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Mariners Weather Log

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Cover: Buoy stands a lonely vigil in a sea of ice on the Hudson River. This winter's severe ice on the rivers and bays damaged and moved many of these important navigational aids. For a description of this past winter, see articles beginning on page 73. U.S. Coast Guard Photo.

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Mariners Weather Log

NORTH ATLANTIC TROPICAL CYCLONES, 1976

Miles B. Lawrence
National Hurricane Center, NOAA
Miami, Fla.

North Atlantic waters were the setting for eight named tropical cyclones during the 1976 hurricane season. Six of these reached hurricane force, and three systems were identified as subtropical storms. Figures 1 and 2 show tracks of the tropical and subtropical cyclones, respectively, and statistical summaries are given in tables 1 and 2.

Tropical cyclone activity was near normal this season, as the annual average for the past 30 yr is nine storms, including six hurricanes. Also, mariners had to contend with 26 hurricane days for the second consecutive year. This compares with a yearly average of 29 hurricane days over the past 2 decades.

Examination of the tracking chart (fig. 1) reveals that there were no tropical cyclones in either the Caribbean or Gulf of Mexico. This lack of activity in both bodies of water in a single season is very unusual and has occurred during only one other year (1962) since the turn of the century.

Another feature of the 1976 season concerns the tracks of hurricanes Emmy and Frances. These storms recurved towards the east at extremely low latitudes. In fact, this southern latitude of recurvature for both storms is unprecedented so early in the season.

Belle and Dottie made landfall along the coast of the United States, although Dottie barely qualified as a tropical storm. This was the first time since 1972 that more than one storm has struck the United States.

Table 2.--Summary of North Atlantic subtropical cyclone statistics, 1976

No.	Dates	Maximum sustained winds (kn)	Lowest pressure (mb)
1	May 21-25	45	994
2 (Anna)	July 28-30	40	999
3	Sept. 13-17	40	1011

A list of ships encountering tropical cyclones during the 1976 season is given in table 3. There were seven reports of hurricane-force winds from four different ships, and these were all taken during Emmy or Frances. The simultaneous existence of hurricanes Emmy and Frances resulted in several ships reporting gale-force winds from both storms.

Timely ship observations continue to play a vital role in the analysis and detection program at the National Hurricane Center. A case in point this season is tropical storm Anna. This system was upgraded to storm status on the basis of a report received from the POINTE ALLEGRE.

Tables 4 and 5 present statistics of tropical cyclones for past years since 1931. Summaries of the extratropical portions of the tropical and subtropical cyclones, if severe, can be found in the appropriate

Table 1.--Summary of North Atlantic tropical cyclone statistics, 1976

No.	Name	Class	Dates	Maximum sustained winds (kn)	Lowest pressure (mb)	U.S. damage ($ million)	Deaths
1	Anna	T	July 28-Aug. 6	40	999		
2	Belle	H	Aug. 6-10	105	957	100	U.S. - 5
3	Candice	H	Aug. 18-24	80	964		
4	Dottie	T	Aug. 17-21	45	996	minor	U.S. - 4
5	Emmy	H	Aug. 20 - Sept. 4	90	974		Azores - 68[1]
6	Frances	H	Aug. 27 - Sept. 7	100	963		
7	Gloria	H	Sept. 26 - Oct. 4	90	970		
8	Holly	H	Oct. 22-28	65	990		

[1]Deaths caused by plane crash at Lajes during height of storm.

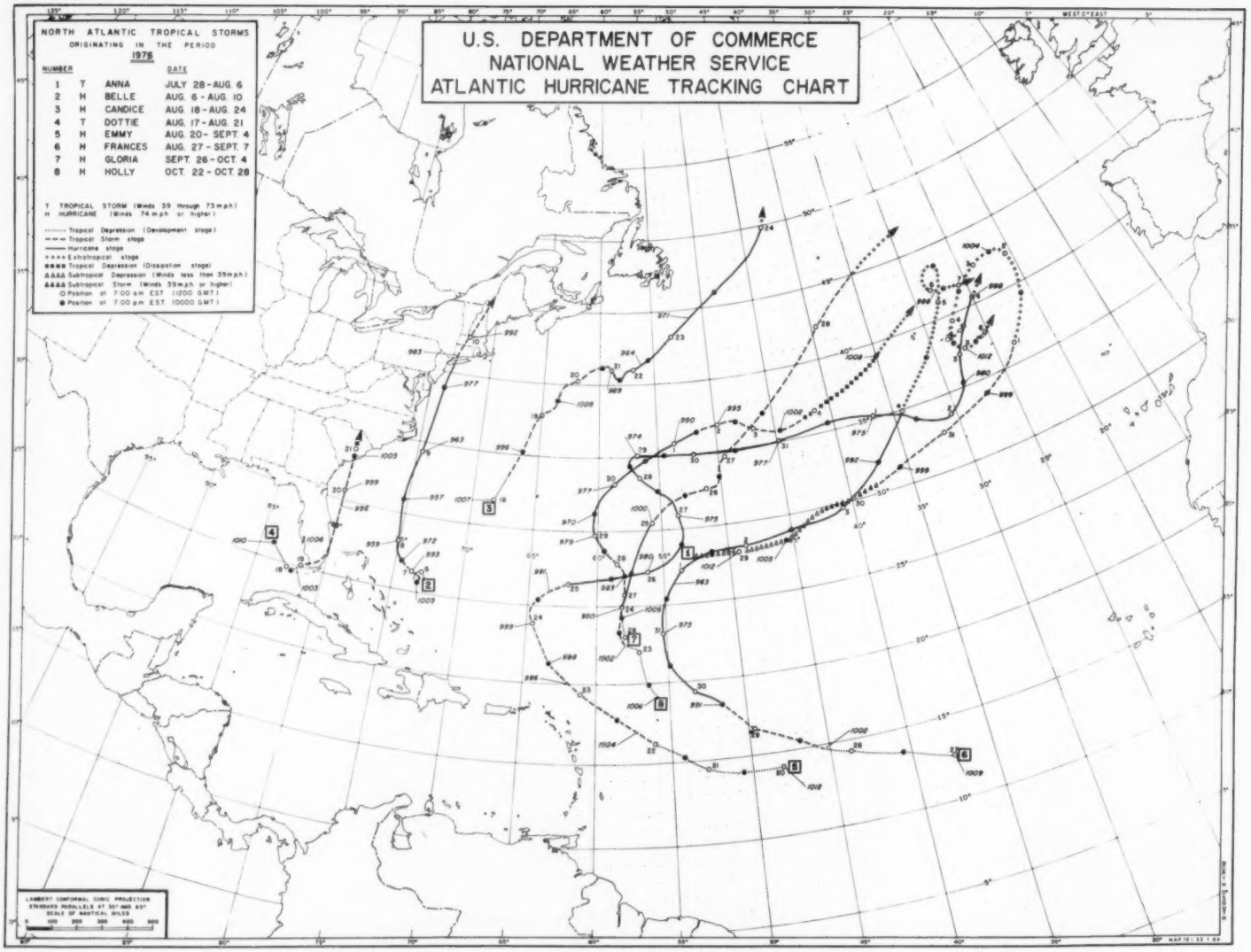
U.S. DEPARTMENT OF COMMERCE
NATIONAL WEATHER SERVICE
ATLANTIC HURRICANE TRACKING CHART
NORTH ATLANTIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
1976
NUMBER
DATE
1 T ANNA JULY 28 - AUG. 6
2 H BELLE AUG. 6 - AUG. 10
3 H CANDICE AUG. 18 - AUG. 24
4 T DOTTIE AUG. 17 - AUG. 21
5 H EMMY AUG. 20 - SEPT. 4
6 H FRANCES AUG. 27 - SEPT. 7
7 H GLORIA SEPT. 26 - OCT. 4
8 H HOLLY OCT. 22 - OCT. 28
T TROPICAL STORM (Winds 39 through 73 m.p.h.)
H HURRICANE (Winds 74 m.p.h. or higher)
Tropical Depression (Development stage)
Tropical Storm stage
Hurricane stage
Extratropical stage
Tropical Depression (Dissipation stage)
Subtropical Depression (Winds less than 39 m.p.h.)
Subtropical Storm (Winds 39 m.p.h. or higher)
Position at 7:00 a.m. EST (1200 GMT)
Position at 7:00 p.m. EST (0000 GMT)

Figure 1.--Tracks of North Atlantic cyclones, 1976.

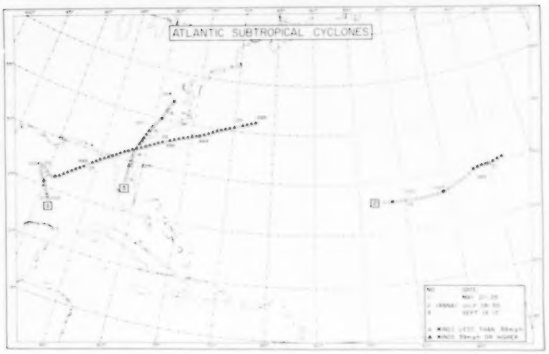

Figure 2.--Tracks of North Atlantic subtropical cyclones, 1976.

Rough and Smooth Logs for the month in which they formed.

TROPICAL STORM ANNA (SUBTROPICAL STORM NO. 2), JULY 28 - AUGUST 6

Anna originated late in July as a subtropical low-pressure system southeast of Bermuda. By July 28, this low was sufficiently well organized to be identified as a subtropical depression. Upgrading to subtropical storm status occurred on the 30th when the POINTE ALLEGRE passed through the storm. The complete plain language report from this ship is given below:

"FNZB. GALE WRNG FROM M/S POINTE ALLEGRE FNZB AT 0200Z JULY 30TH PSN 29.3N 13.0W COURSE 230 SPEED 18.5 KNOTS AFTER THUNDER STORMS WITH HEAVY RAIN SE WINDS INCREASING SUDDENLY TO STORM WITH GUSTS UP TO 60 KNOTS BAROMETER FORMERLY 1014 MBS FALLING DOWN QUICKLY TO 999 MBS STOP AT 0300Z STORMY WINDS TURNING TO SSW THEN W HEAVY SEAS SHIP COURSE 210 SPEED 11 KNOTS THEN BAROMETER RISING QUICKLY TO 1010 MBS STOP AT 0500Z WINDS VEERING TO NW AND DECREASING TO 6/7."

The National Hurricane Center cannot overemphasize the importance of this kind of data, even with the advancing technology of meteorological satellites.

By this time, the storm was moving northeastward and acquiring tropical characteristics. It was named tropical storm Anna later on the 30th and continued toward the Azores (fig. 3). Weakening, Anna began a slow counterclockwise loop through the Azores and became extratropical on August 6.

Anna's minimum pressure was 999 mb and maximum sustained winds were 45 kn on August 2. The Azores received only fringe effects from the storm with all island wind reports below gale force.

HURRICANE BELLE, AUGUST 6-10

The forerunner of Belle was a tropical wave crossing the Atlantic in the trade wind belt during late July and early August. Cloudiness associated with this system reached a position just east of the northern Bahamas on August 5. A tropical depression formed in this location on the next day.

The depression strengthened, becoming a tropical storm at 0000 on the 7th and a hurricane at 1800 on the same day. The COLUMBUS NEW ZEALAND, just north of the storm's center, was the first ship to report gale-force winds. By the 8th, Belle was moving northward at 20 to 25 kn. She made landfall at 1000 on the 10th on southern Long Island. During the last 24 hr prior to landfall, five different ships reported gale-force winds or higher with 60 kn from the EXXON BALTIMORE off the North Carolina coast.

Belle's maximum strength was attained early on August 9 while she was 250 mi south of Cape Hatteras. Sustained winds were 105 kn, and minimum sea level pressure was 957 mb. Figure 4 is a satellite picture of Belle at this time; figure 5 shows a radar presentation of the hurricane several hours later.

Figure 3.--Tropical storm Anna south of the Azores at midday on July 31.

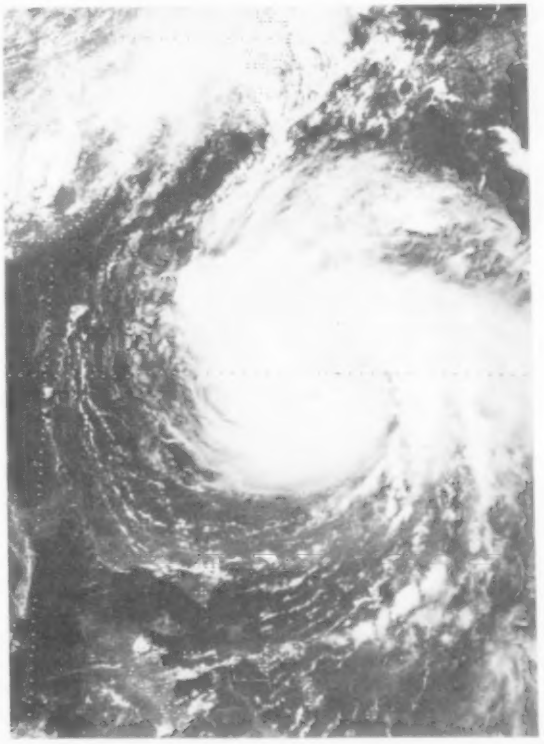

Figure 4.--Hurricane Belle near time of maximum intensity, 300 mi south of Cape Hatteras.

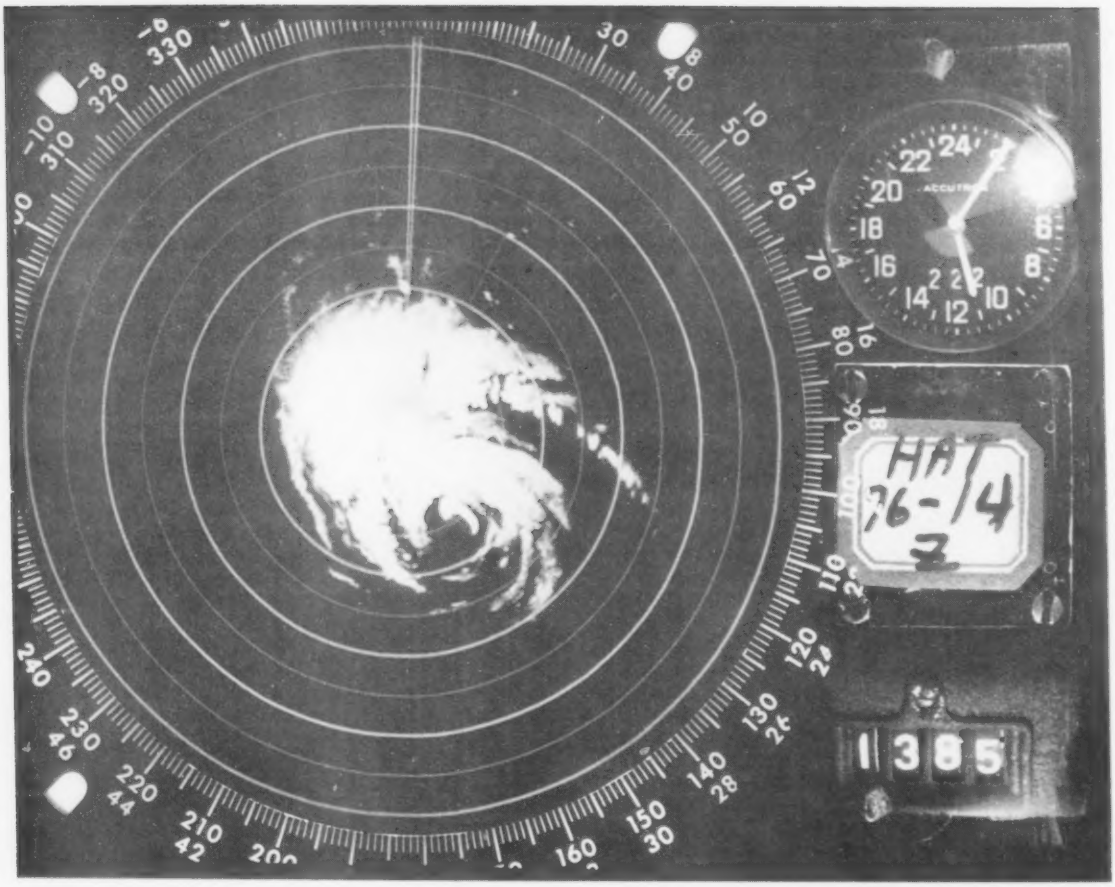

Figure 5.--Hatteras radar picture of Belle at 1105 GMT August 9.

While moving northward, parallel to the U.S. East Coast, Belle affected several ocean observing platforms. NOAA buoy EB15 (32°N, 75.2°W) was almost directly in the path of the storm. Maximum winds reported from this buoy were 60 kn at 0600 on the 9th, but a pressure was not available. It is interesting that this wind measurement is based on a several-minute average; the fastest mile was probably considerably higher than 60 kn.

NOAA buoy EB41 (38.7°N, 73.6°W), also in the path of Belle, measured only gale-force winds. OWS Hotel (38.0°N, 71.0°W) was well east of the track, and it also reported gales.

By landfall, Belle's maximum sustained winds were 65 kn and minimum pressure 980 mb. Hence, she decreased from a major, dangerous hurricane to a minimal one during the 24 hr prior to moving inland.

One explanation for this weakening is that Belle's northward motion remained at speeds less than 25 kn. Therefore, more time was available for the storm to travel over the colder waters of the Atlantic north of the Gulf Stream, which veers eastward away from the coast just north of Cape Hatteras. Most of the major storms that have affected the northeastern United States did not have as much time over colder water and accelerated to speeds higher than Belle.

This was fortunate for residents of the warning area. A not-so-fortunate side effect was that many of these residents may have been lulled into a false sense of security, if they based their hurricane preparedness on this single experience.

Wind damage was minimal. Maximum gusts of 80 kn were reported along the coast of New Jersey and on Long Island. Table 6 gives a summary of coastal station meteorological data.

Tides were mainly 3 ft above normal along the affected coast, with some below-normal tides from New Jersey southward caused by an offshore wind component. Battery Park on Manhattan Island reported 4.5 ft above normal, and higher tides were likely on southern Long Island.

Rainfall of 4 to 5 in was common during Belle's passage, and this extended inland to the mountains of New England. Stream flooding and flooded roads occurred, but crop damage, although significant, was less than anticipated.

Five fatalities have been ascribed to the storm. It is estimated that one-half million people evacuated

Table 3.--Ships encountering tropical cyclones in the North Atlantic during 1976

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb	Temperature °C		Sea Waves*		Swell Waves	
			Lat. deg	Long. deg		Dir. 10°	Speed kt.				Air	Sea	Period sec.	Height ft	Dir. 10°	Period sec	Height ft
SUBTROPICAL STORM NO. 1		MAY															
KIEM	U.S.A.	21	26.5	87.9	18	14	35			1012.9			02	11	14	12	19
EXXON FLORENCE	U.S.A.	22	26.2	87.5	18	25	35			1007.0			02	3	25	5	10
SOLON TRUMAN	U.S.A.	22	28.2	90.2	18	07	40			1005.8			03	5	07	7	19
SHIP		23	26.8	83.3	12	SSE	40							14			
OCEANIC	U.S.A.	24	29.7	75.0	12	22	35			1002.4			06	6			
EXXON HUNTINGTON	U.S.A.	24	32.0	76.7	12	20	35			997.6				14			
CARBIDE	U.S.A.	24	31.0	80.0	12	23	35			997.0			05	5	23	8	8
ANNA (SUBTROPICAL STORM NO. 2)		JULY															
POINTE ALLEGRE	FRANCE	30	29.3	43.0	02	14	35			999				"Heavy"			
BELLE		AUG.															
COLUMBUS NEW ZEALAND	GERMANY	7	28.7	75.2	18	08	35			1013.5							
LQPA	ARGENTINA	9	36.0	73.2	12	11	37			1007.2			04	12			
LRRQ	ARGENTINA	9	34.8	71.2	12	16	36			1010.5			05	8	16	10	8
LRRQ	ARGENTINA	9	35.4	71.2	15	17	39			1009.8			05	8	17	10	6
GULFQUEEN	U.S.A.	9	35.2	68.3	18	16	39			1021.0			03	3	15	8	6
EXXON BALTIMORE	U.S.A.	9	36.2	73.0	18	18	60			1000.7			18	55	18	14	55
LRRQ	U.S.A.	9	36.2	70.9	18	17	50			1013.3			05	13	17		10
LQPA	U.S.A.	9	35.5	72.1	18	17	44			1007.8			05	13			14
SHIP		10	41.8	70.2	06	14	35			1011.8			04	3			
PBRQ	BRAZIL	10	38.7	71.2	06	18	37			1013.0			05	13	18		10
CANDICE		AUG.															
VALVANUZ	SPAIN	19	39.0	61.5	18	19	39			1019.9				6			
WESER ORE	LIBERIA	20	42.4	62.8	00	06	40			1021.3			06	13	07	8	13
MANCHESTER VIGOUR	U.K.	20	40.1	64.9	06	33	52			1009.7			08	16	34	9	23
MANCHESTER VIGOUR	U.K.	20	40.1	64.8	12	33	56			1014.9			06	18	33	9	19
MUREX	FRANCE	20	39.4	65.0	15	30	38							8	32	13	13
MANCHESTER VIGOUR	U.K.	20	39.6	64.2	18	31	50			1017.8				16	33	9	19
DART ATLANTIC	U.K.	20	39.9	59.2	18	21	38			1010.6			04	6	25	14	16
BAKAR	NORWAY	21	40.3	59.0	18	32	45			993.0			12	32			
DOCTOR LYKES	U.S.A.	22	36.7	57.4	12	23	34			1013.7			07	10	28	7	10
ATLANTIC CHAMPAGNE	FRANCE	22	40.1	54.3	18	22	36			1010.0			06	11	26	9	32
DOTTIE		AUG.															
MOBIL FUEL	U.S.A.	20	34.2	76.2	00	03	40			1020.7			07	10			
DWFM	PHILIPPINES	20	27.3	79.2	00	20	35			1009.5			07	11			
SALAND	NETHERLANDS	20	32.1	77.6	18	16	40			1013.7			04	10	14	7	13
EMMY		AUG.															
BAR	GERMANY	20	18.1	51.4	15	17	40			1016.8			06	6	5		10
SEA MOON	U.K.	25	26.1	60.0	18	SSW	65			1016							
NIENBURG	U.S.A.	25	25.0	60.3	16	20	40			1011.0			06	16	22	8	19
PALMIRO TOGLIATTI	U.S.S.R.	25	26.6	60.6	18	03	35			991.0				13	03		19
SEA MOON	U.K.	25	26.4	59.6	21	22	65			1003							
NIENBURG	U.S.A.	25	25.2	59.0	21	21	52			1010.6			06	13	22	7	19
SEA MOON	U.K.	26	26.4	59.2	00	18	70			998				"Phenomenal"			
SEA MOON	U.K.	26	27.0	59.3	03	N	70			1003				"Phenomenal"			
SEA MOON	U.K.	26	27.4	59.4	06	NNE	60			1008				"Very High"			
ANJOU	FRANCE	26	36.1	54.3	09	36	40			1011.0				14	36	8	19
VEGESACK	GERMANY	27	31.1	55.5	12	36	37			1007.4			06	10	03		13
GREEN PORT	U.S.A.	28	35.4	52.9	18	09	40			1020.7			06	13	07	14	13
GREEN PORT	U.S.A.	29	32.9	54.3	12	18	35						06	10	23	6	10
STEPHANITOR	GERMANY	29	34.9	54.7	18	16	32			997.0			09	26			
STEPHANITOR	GERMANY	29	34.8	54.7	21	18	60			998.2			09	18			
STEPHANITOR	GERMANY	30	34.8	53.9	00	16	60			992.1			08	24	17	10	19
UCLF	U.S.S.R.	30	34.7	50.5	12	18	37			1000.5			06	11	22	10	11
GUAVACORE	GERMANY	30	34.2	49.6	12	18	37			1007.0			08	18	22		23
BAYERNSTEIN	GERMANY	30	37.9	47.1	18	11	37			1009.0			04	8	11	7	13
KJVG	U.S.A.	30	30.9	50.2	18	25	38			1009.5			12	16	25	14	14
FALSTRIA	DENMARK	30	35.8	49.9	18	13	45			998.0			06	13			13
BAYERNSTEIN	GERMANY	30	35.6	46.2	21	12	37			997.0			08	16	25		
GUAVACORE	GERMANY	31	36.2	46.7	00	07	60			1003.5				18	15	12	23
DHR	GERMANY	31	32.1	45.6	09	24	40			1009.3			04	5	24	11	10
ALPHAGAS	GERMANY	31	35.0	44.8	09	18	60			989.0			06	13	21	8	16
POLAR BRAZIL	GERMANY	31	31.1	46.1	12	27	40			1012.2			03	6	30	12	16
NRLW	U.S.A.	31	32.3	41.7	12	22	40			1008.5			02	11	22	5	19
WJKD	U.S.A.	31	32.8	42.0	12	21	40			1008.5			05	8	21	6	16
DHR	GERMANY	31	32.3	44.5	12	26	44			1009.2			06	6	26	12	13
GUAVACORE	GERMANY	31	38.3	46.1	12	07	40			1006.7			10	16	06	12	19
BLUMENTHAL	GERMANY	31	39.7	40.5	18	08	33			1009.0			07	10	08	8	10
MINDEN	GERMANY	31	31.0	44.3	18	27	44			1010.0			09	11	27		11
ALPHAGAS	GERMANY	31	36.1	45.1	18	03	60			1010.0			06	14			
DHR	GERMANY	31	31.8	44.2	18	26	60			1009.5			03	11	25	10	19
WJKD	U.S.A.	31	34.2	38.8	18	19	35			1006.5			05	10	18	6	16
WILDENFELS	GERMANY	31	36.9	39.1	21	09	40			997.5				10	33		
		SEPT.															
FORT SAINTE MARIE	FRANCE	1	33.5	37.2	06	21	45			995.0			10	11			
FORT SAINTE MARIE	FRANCE	1	33.4	37.3	09	22	50			993.6			04	32			
FORT SAINTE MARIE	FRANCE	1	33.0	37.6	12	24	70			993.5							
PACIFIC	SWEDEN	1	32.0	38.0	12	24	44			1002.0			20	26			
ORE-JUPITER	LIBERIA	1	33.4	36.1	12	25	60			987.2				24	25	10	32
GEESTSTAR	U.K.	1	37.8	34.0	12	09	35			1004.6			03	6	10	6	13
ORTECA	U.K.	1	30.7	38.0	12	17	40			1010.6					29	6	35
ORTECA	U.K.	1	30.6	38.7	18	30	41			1010.2			01	26	29	7	32
FORT SAINTE MARIE	FRANCE	1	30.2	37.6	18	29	38			1004.8			04	26			
HQUX	HONDURAS	1	30.2	35.2	18	30	56			1007.8			06	16	27	13	16
FORT SAINTE MARIE	FRANCE	1	31.4	37.7	21	29	38			1009.0			06	8			
HQUX	HONDURAS	2	30.6	35.3	00	30	60			1005.1			05	27			45
ORE-JUPITER	LIBERIA	2	34.5	34.1	00	26	60			978.0				24	26	10	32
HQUX	HONDURAS	2	29.3	35.3	06	27	60			1007.8			06	39	27	12	26
HQUX	HONDURAS	2	30.0	36.2	09	32	40			1009.1			05	14	30		24
DMBH	ITALY	2	29.5	29.9	09	24	35			1001							
ORE-JUPITER	LIBERIA	2	35.6	32.2	12	04	55			992.0				24	05	10	24
POLAR BRAZIL	GERMANY	2	33.5	35.0	12	33	45			1015.5			04	6	32	8	10
JOHN PENN	U.S.A.	2	28.2	30.4	12	23	34			1012.5			12	13	28	8	14
DHR	GERMANY	2	38.6	36.9	12	05	47			1014.2			03	5	05	9	10
HQUX	HONDURAS	2	31.3	33.8	18	32	40			1009.1			05	13			
ORE-JUPITER	LIBERIA	2	36.0	31.3	18	04	55			992.0				24	04	10	24
BRUCE GITTY	LIBERIA	3	33.8	33.2	00	36	56			1010.0			06	6	36	14	8
ASPRELLA	U.K.	3	41.5	24.5	06	07	35			997.6			03	8			11
ORE-JUPITER	LIBERIA	3	37.2	29.5	12	35	55			987.0				24			
HANNOVER	GERMANY	3	38.0	30.2	18	35	33			999.2			05	10	03	10	10
ORTECA	U.K.	3	38.1	36.1	18	35	39			1013.5			06	10	04	6	26
MEGANTIC	U.K.	4	40.8	32.2	00	02	40			1010.4			07	11	02	10	32
ORE-JUPITER	LIBERIA	4	37.5	28.5	00	31	50			992.0				16	01	10	18
ORE-JUPITER	LIBERIA	4	39.4	25.6	18	24	40			1001.0				18	24	10	18
KRLX	U.S.A.	4	41.5	25.8	18	07	35			1009.5			05	5	25	9	11

Table 3. (con't)--Ships encountering tropical cyclones in the North Atlantic during 1976

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb	Temperature		Sea Waves*			Swell Waves		
			Lat. deg	Long deg		Dir. 10°	Speed kt				Air	Sea	Period sec	Height ft	Dir. 10°	Period sec	Height ft
FRANCES		AUG.																
HOUX	HONDURAS	29	18.1	47.9	06	05	20			1011.9			05	4	12	< 5	16
HOUX	HONDURAS	29	19.2	46.9	12	09	40			1013.9			05	10	12	< 5	16
DOCENES	NETHERLANDS	31	21.6	52.3	06	16	25			1010.5					15	11	19
DOCENES	NETHERLANDS	31	21.1	52.0	09	17	24			1012.4			07	10	25	9	19
SUGAR PRODUCER	U.K.	31	26.1	57.8	18	04	25			1011.2			08	13	13	12	19
SUGAR PRODUCER	U.K.	SEPT. 1	27.8	56.4	12	26	24			1008.9			07	19	02	11	27
MINDEN	GERMANY	1	25.7	50.8	21	20	27			1009.7			09	10	22	12	14
CODEX FRASER	LIBERIA	2	24.5	46.2	11	22	21			1010.8			04	11	22	< 5	11
MERIDIAN	FRANCE	3	24.0	50.7	00	30	00			1007.3							
JOYO MARU	JAPAN	3	25.7	47.3	00	28	21			1017.7							
PYORAN MARU	JAPAN	4	24.4	39.0	00	05	27			1008.5			07	11	07	9	16
ORTEGA	U.K.	4	26.2	34.5	06	01	27			1008.8			05	6	01	< 5	22
HELLBRONN	GERMANY	4	26.2	33.0	12	09	27			998.6			08	6	07	10	11
DIXI	GERMANY	4	25.7	34.4	12	05	25			998.6							
HANOVER	GERMANY	4	26.0	35.9	12	09	27			997.5			07	8	05	11	11
MONSTAL	U.K.	4	26.8	37.7	12	25	24						06	10	05	6	10
PPH	BRAZIL	4	32.9	37.5	12	29	24			1009.0			06	8	25	9	27
ORTEGA	U.K.	4	40.5	33.3	18	08	27			1005.5			05	6	07	< 5	19
HELLBRONN	GERMANY	4	37.1	32.8	18	04	24			995.2			07	8		10	11
ORTEGA	U.K.	5	41.8	30.2	12	06	44			1001.5			05	6	08	< 5	26
NOAY	U.S.A.	5	39.1	25.9	12	23	42			1007.5			02	5	22	7	14
ORE-JUPITER	LIBERIA	5	41.2	22.6	12	13	40			1005.6				16	12	10	23
AZETAL PILOT	U.S.A.	5	38.0	27.2	12	22	23			1007.0			04	19	22	< 5	19
HELLBRONN	GERMANY	5	41.8	31.5	12	05	27			1008.1			08	6	05	13	13
SUFFREN	FRANCE	5	44.0	30.2	12	07	40			1008.2			07	23			
ANONACORE	GERMANY	6	45.3	27.7	18	07	24			1010.0			08	10	09	8	13
ARNINO	U.K.	7	40.0	22.2	12	15	24			1007.5			07	10	15	8	11
BISCHOFSTEIN	GERMANY	7	42.9	20.1	12	26	40			1012.5			04	8	02		13
BISCHOFSTEIN	GERMANY	7	44.4	22.3	18	02	42			1010.5			04	8	02	7	13
SUBTROPICAL STORM NO. 3		SEPT.																
RAVA-ROISSKAYA	U.S.S.R.	14	28.5	78.3	06	11	29			1018.2			06	8			
MORNEAU.TAIR	U.S.A.	14	31.3	79.6	12	12	24			1012.2			06	6	12	< 5	10
VALLEY FORGE	U.S.A.	15	34.9	76.0	12	13	25			1017.6			04	10	12	10	19
GLORIA		SEPT.																
STAINWORTH	U.K.	25	24.4	52.8	18	08	41						03	5	10	12	6
NAESS LOUISIANA	U.K.	30	24.1	52.3	18	15	40			1013.0							
		OCT.																
BRENVARD	NORWAY	1	32.5	58.2	18	23	41			1017.2			03	5			
PEDRO TEIXEIRA	BRAZIL	2	30.1	53.5	00	25	25			1013.0							
FRANKFURT	GERMANY	5	38.9	32.2	00	22	23			1007.0			11	22			8
HOLLY		OCT.																
	NORWAY	22	22.7	52.7	12	11	23			1012.5				13			15
PISK KUCHATOV	U.S.S.R.	24	29.1	62.1	06	03	27			1017.6							
WCHF	U.S.A.	24	30.4	61.6	12	04	25			1018.2			07	13	24	10	16
DEAE	GERMANY	24	29.8	60.1	12	03	27			1016.0			04	6	03	8	11
BALAO	NORWAY	24	28.3	62.3	18	06	25			1022.0			12	10	03	5	11
DIIB	GERMANY	24	27.0	62.3	18	14	23			1012.1			02	5	24	7	10
DEAE	GERMANY	24	29.4	61.9	18	04	27			1016.2			03	6	03	7	11
BALAO	NORWAY	25	28.9	62.1	00	04	23			1022.0			12	10	03	6	11
SHIP		25	28.7	62.0	00	03	40			1013.0			05	11	06	7	16
HORNCOLK	GERMANY	25	29.7	59.1	18	17	27			1018.8			09	10	17	14	11
CINTIA	NETHERLANDS	25	31.3	48.9	00	19	25			1010.2							
BARANJA	YUGOSLAVIA	25	28.3	49.4	12	06	27			1013.0							
JAPAN WISTERIA	JAPAN	25	31.6	49.2	12	20	23			1006.3			06	14	22	9	16
ALMERIA LYKES	U.S.A.	26	41.2	50.2	12	09	25			1029.2			06	5	03	9	6
BARANJA	YUGOSLAVIA	26	28.7	47.9	18	06	27			1012.0			06	13			
EXPORT BILDER	U.S.A.	28	40.7	38.9	12	17	25			1003.9			02	3	17	7	16

* Direction of sea waves same as wind direction.

in anticipation of the danger of Belle's storm surge. The dollar damage estimate is $100 million.

HURRICANE CANDICE, AUGUST 18-24

The disturbed weather which developed into Candice was detected on satellite pictures as early as August 11, 500 mi southeast of Bermuda. By the 18th, this system had developed into a tropical depression and had moved to about 200 mi west of Bermuda.

Intensification ensued and the depression was named tropical storm Candice later on the same day. It moved northeastward and weakened a little on the 19th. The VALVANUZ, northwest of the storm's center, and the CHEVRON NEDERLAND to the northeast both encountered gales late on the 19th.

The storm intensified again on the next day, and it reached hurricane status on the 21st. During this period, several ships were affected by Candice. The MANCHESTER VIGOUR reported 50-kn winds three separate times on the 20th along with a maximum sea height of 18 ft and 21-ft swells. The BAKAR experienced 32-ft waves on the 21st and 45-kn steady winds at a position slightly southwest of the storm's center.

Maximum strength was reached on August 22 as the pressure fell to 964 mb and winds reached 80 kn (fig. 6). On the 24th, the hurricane was overtaken by a cold front east of Cape Race, Newfoundland. It quickly lost its identity as a tropical system while accelerating northeastward over the open North Atlantic.

Figure 6.--Hurricane Candice at top of picture near time of maximum intensity and moving across North Atlantic shipping lanes. Emmy can be seen at lower right just after reaching tropical storm stage.

Table 4

NORTH ATLANTIC TROPICAL CYCLONES FOR PAST YEARS

Year	Total Number Tropical Cyclones*		Total Number Hurricanes		Loss of Life		Damage by Categories**	
	All Areas	Reaching U.S. Coast	All Areas	Reaching U.S. Coast	Total All Areas	United States	Total All Areas	United States
1931	9	2	2	0		6		4
1932	11	5	6	2		8		4
1933	21	3	9	5		63		7
1934	15	6	4	3		17		6
1935	6	2	5	2		414		7
	66	23	26	12				
1936	16	7	7	3		9		6
1937	9	4	3	0		0		0
1938	9	4	3	2		600		9
1939	5	3	1	1		3		3
1940	8	3	4	2		51		6
	66	21	20	8				
1941	6	4	4	2		10		7
1942	10	5	3	2	17	8	7	7
1943	10	6	5	1	19	16	7	7
1944	11	3	7	3	1,075	66	8	8
1945	11	3	5	2	20	7	8	6
	48	20	25	13				
1946	8	1	3	1	5	0	7	7
1947	7	2	3	1	72	53	6	6
1948	9	4	6	3	24	3	7	7
1949	13	5	7	2	4	4	8	8
1950	13	4	11	5	27	19	7	7
	50	22	32	12				
1951	10	5	8	0	244	0	7	6
1952	7	3	6	1	16	3	6	6
1953	14	6	5	2	3	2	7	7
1954	11	4	8	3	730	193	9	9
1955	12	5	6	3	1,514	214	9	9
	54	23	33	9				
1956	8	2	4	1	76	27	8	7
1957	9	3	3	1	171	390	9	9
1958	10	1	7	0	39	2	7	7
1959	11	7	7	3	37	24	7	7
1960	7	5	4	2	183	63	8	8
	54	20	25	7				
1961	11	3	6	1	345	46	8	8
1962	5	1	3	0	4	4	6	6
1963	9	1	7	1	7,215	11	9	7
1964	12	4	6	4	208	49	9	9
1965	6	2	4	1	76	75	9	9
	43	11	26	7				
1966	11	2	7	2	1,040	54	8	7
1967	8	3	6	1	68	14	8	8
1968	9	3	4	1	11	9	7	7
1969	13	3	10	2	364	256	9	9
1970	7	4	3	1	74	11	9	8
	48	14	30	7				
1971	12	5	5	3	44	6	8	8
1972	4	3	3	1	124	121	9	9
1973	7	1	4	0	16	5	7	7
1974	7	1	4	1	3,000+	1	8	8
1975	6	1	4	1	90	22	9	9
	36	11	22	6				
1976	8	2	6	1	77	9	8	8
Total	435	167	253	80				
Mean	9.5	3.6	5.5	1.8				

**The Environmental Data Service has for some time recognized that, without detailed expert appraisal of damage, all figures published are merely approximations. Since errors in dollar estimates vary in proportion of the total damage, storms are placed in categories varying from 1 to 9 as follows:

1 Less than $50
2 $50 to $500
3 $500 to $5,000
4 $5,000 to $50,000
5 $50,000 to $500,000
6 $500,000 to $5,000,000
7 $5,000,000 to $50,000,000
8 $50,000,000 to $500,000,000
9 $500,000,000 to $5,000,000,000

*Including hurricanes
• Not reported in literature, believed minor.
- Additional deaths for which figures are not available.

Table 4.--Meteorological data, hurricane Belle, August 6-10, 1976

Station	Date	Pressure (inches) Low	Pressure (inches) Time	Wind (miles per hour) 1 min average	Wind (miles per hour) Time	Wind (miles per hour) Gusts	Wind (miles per hour) Time	Highest Tide (feet above MLW)	Time	Rainfall (inches)	Remarks
Data from ESSA (35.3°N, 75.7°W)	9	991.1	0530	80	01	0500					4.3 min average wind
Data from CBAL (33.7°N, 75.4°W)	9	994.7	1400	102	07	1400					10 min average wind
CONNECTICUT											
Bridgeport	10					77	0500				
Hartford	10	992.2	0315	7	00	0540		4.1	0545	1.10	
New London	9							1.0	2130		
DELAWARE											
Wilmington	9	1005.1	1100	1000	09	1015	09	1.1	1115	0.1	1100 0.01
MAINE											
Portland	10	1004.7		0	20	1040	0	0.2	1001		
MARYLAND											
Ocean City	9	1001.0	1000		00	1100		0.5	1700	4.0	1700 0.20
MASSACHUSETTS											
Ashfield	10									0.11	
Barrington	10									0.21	
Boston	10									0.05	
Boston	10	1001.9	0715	0	24	0150	0	14	0451	1.4	0400 .05
Gloucester	10			09	40	1700					
North Adams	10									0.33	
Scituate	10			004	46	2700					
NEW HAMPSHIRE											
Concord	10	1001.4	0654				10	0440			.09
NEW JERSEY											
Atlantic City	9	001.0	2040	052	40	1400	051	02	1441	0.42	1321 0.06
Atlantic City Airport	9			056	20	2330	050	40	2011		0.71
Avalon	9	2014.2	1730	050	50	1730	050	50	1730		0.45
Beach Haven	9	2004.0	1000	33	45	2300	09	2300			0.31
Cape May	9	003.0	1101	058	21	1	058	54	2000	2.6	2.65
Cape May Court House	9			9035	32	2055	035	55	2035		1.10
Manasquin	9						05	2035	2035		1.10
Margate	9										0.10
Mercer County Airport	9				40			45	2241		
North Wildwood	9			058	45	1400	058	50	1456	3.5	1400
Seaside Heights	9			05	40		05	50	2000		
Ship Bottom	9			05	45			00			
Trenton	9	1006.0	2130	058	36	2327					1.10
Wildwood Coast	9			058	50	1700	058	45	1440		
NEW YORK											
Central Park	10			9	19		059	46	1106		0.09
Garden City	9	007.1	2351								
Islip	10	005.2	0100								
JFK	9	007.0	2251	059	42	2141	057	40	2126		
LaGuardia	95	005.2	0051	05	32	2251	05	45	2102		0.20
New York City	10	004.5	0000							1.5	
NORTH CAROLINA											
Cape Hatteras	9	994.9	0040	059	37	0050	059	03 052	0047		0.50
Frisco	9							053			
Hatteras Place	9							053			
Wilmington	9	002.8	0241	05	16	0003	059	10	1455		
PENNSYLVANIA											
Philadelphia	8	005.1	2130		00			45	2046		0.30
RHODE ISLAND											
Block Island	10							74			
Providence	10	007.5	0230	05	44	0303	0	00	0445	0.3	0400 0.77
VIRGINIA											
Norfolk	9	1003.1	1300	S	32	1152	N	48	1140	1.0	1100 1.26
Oceana NAS	8						059	40			
(north Island (Chesapeake Bay Bridge)	7						059	03			

+ Eastern Standard Time
E Estimated
M Tide above Mean Low Water
• Above normal

Table 5

NORTH ATLANTIC TROPICAL CYCLONES FOR PAST YEARS

		Frequency of Tropical Cyclones (including Hurricanes) by Months and Years									Frequency of Tropical Cyclones Reaching Hurricane Intensity by Months and Years								
		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1931			1	1	2	3	1	1		9	1931					2				2
1932		1			2	3	3	1		11	1932				1	1	1			3
1933		1	1	3	7	5	3	1		21	1933				2	3	1			6
1934		1	1	1	2	2	3	1		11	1934		1	1	1	1	1	1		6
1935					3	1	2			6	1935				2	1	2			5
1936			3	2	6	4	1			16	1936		1	1	3	2				7
1937				1	2	6				9	1937					3				3
1938					3	1	2	1		9	1938				3	1				5
1939			1		1	1	2			5	1939				1		2			3
1940		1			3	2	2			8	1940				3	1				4
1941						4	2			6	1941				3	1				4
1942					3	3	3	1		10	1942			3			1			4
1943				1	2	4	3			10	1943			1	1	2	1			5
1944				3	2	4	2			11	1944			2	1	3	1			7
1945			1	1	4	3	2			11	1945		1		1	1	2			5
1946			1	1	1	1	2			6	1946			1		1				2
1947				1	2	3	3			9	1947				2	1	2			5
1948		1		1	2	3	1	1		9	1948				1	3	1	1		6
1949					3	7	2	1		13	1949				2	4	1			7
1950					4	3	6			13	1950				4	3	4			11
1951		1			3	4	2			10	1951	1			2	3	2			8
1952	(Feb.) 1				2	2	2			7	1952				2	2	2			6
1953		1			3	4	4	1	1	14	1953				2	3	1			6
1954			1	1	2	4	1	1	1	11	1954		1		2	3	1		1	8
1955				1	4	5	2			12	1955				3	3	1			6
1956			1	1	1	4	1			8	1956			1	1	1	1			4
1957			2		1	4	1			8	1957		1			2				3
1958			1		4	4	1			10	1958				3	3	1			7
1959		1	2	2	1	3	2			11	1959		1	2		3	1			7
1960			1	2	1	3				7	1960			2	1	2				4
1961				1		6	2	2		11	1961			1		5	1	1		8
1962					2	2	1			5	1962				1	1	1			3
1963				1	1	5	2			9	1963			1	1	4	1			7
1964			1	1	4	4	1	1		12	1964				2	3	1			6
1965			1		2	2	1			6	1965				2	1	1			4
1966			1	4	1	4		1		11	1966				1	1				2
1967					1	4	3			8	1967		1	3		1	1	1		7
1968			3		1	2	1			7	1968		2			1	3			6
1969				1	6	2	3	1		13	1969				1	5	2	1		10
1970		1		2	1	3				7	1970	1		1		1				2
1971				1	3	6	1	1		12	1971				1	4				5
1972			1		2	1				4	1972		1		1	1				3
1973				1	2	2	2			7	1973			1	1	1	1			4
1974					3	4				7	1974				3	3				6
1975			1	1	2	3	1			8	1975			1	2	3				6
1976				1	5	1	1			8	1976				4	1	1			6
Totals	(Feb.) 1	9	25	37	113	133	81	16	2	435		2	11	19	74	96	43	7	1	253

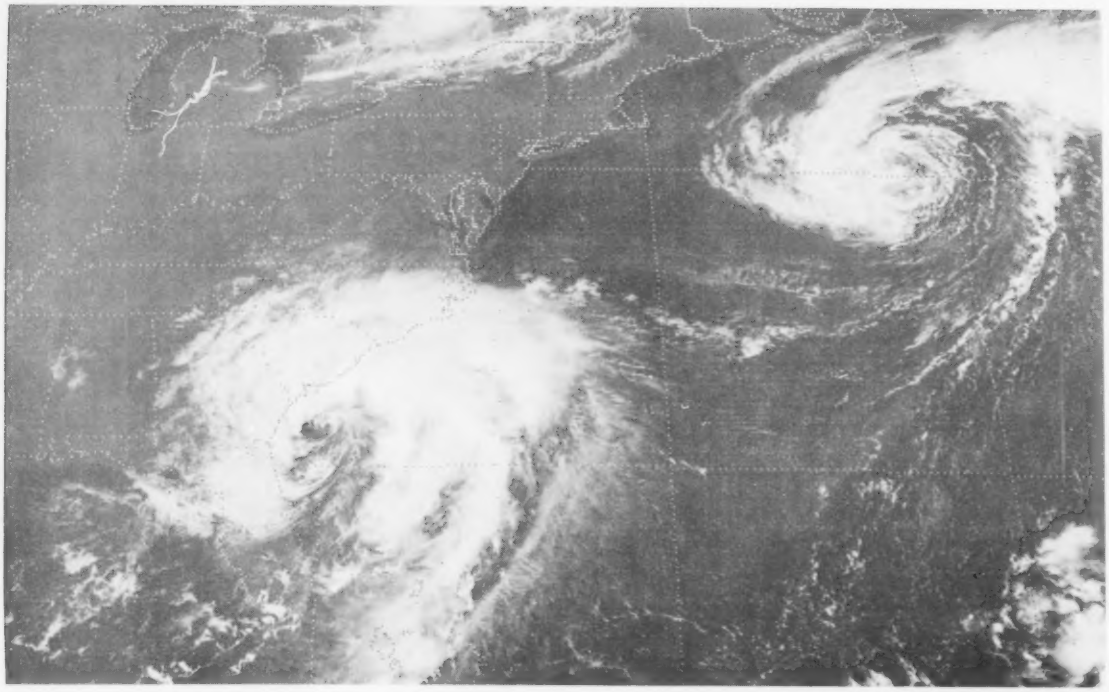

Figure 7.--Tropical storm Dottie several hours before landfall near Charleston. Candice can also be seen south of Nova Scotia.

TROPICAL STORM DOTTIE, AUGUST 17-21

As can be seen from the tracking chart (fig. 1), Dottie did not travel over much open water and did not constitute a significant problem for marine interests. Only three ships reported gale-force winds in association with this storm; however, four deaths resulted when a fishing boat sank on August 19 near Grand Bahama Bank in the Bahama Islands.

The low which became Dottie formed northwest of Key West on August 17. It drifted east-northeastward for 24 hr and then accelerated across southern Florida. It was named on the 19th after reaching the Atlantic near Palm Beach. Post analysis indicated that storm strength was attained while the system was still in the Florida Keys, and the official track reflects this adjustment.

Over the Atlantic, the storm moved due north for 24 hr and went inland near Charleston, S.C., late on the 20th. Figure 7 shows Dottie several hours before landfall.

Reconnaissance aircraft measured the system's maximum strength at 0200 on the 20th with 996 mb and 45 kn. Weakening occurred thereafter, and Dottie was barely of storm strength at landfall. Tides ranged up to 3.5 ft above normal from northern Florida through the Carolinas. Significant rainfall includes 7.78 in at Carolina Beach, N.C., and 8.00 in near Miami, Fla.

A low-pressure center forming the remnant of Dottie moved back over the water on the 22d. It almost retraced the storm track, southward and then southwestward, across central Florida into the Gulf where it lost its identity on the 25th. This portion of the history of Dottie is not included in the track as no significant weather occurred.

HURRICANE EMMY, AUGUST 20 - SEPTEMBER 4

Hurricane Emmy traversed the central North Atlantic, and more ships encountered gale-force winds or higher than any other storm during the 1976 season (See table 3). All reports of hurricane-force winds this season, except one, were from ships within the influence of Emmy.

A depression formed 1,000 mi east of the Windwards on August 20. Moving northwestward, the system became tropical storm Emmy 2 days later, 300 mi east of the Leeward Islands. Northwest motion continued until the 24th when the storm turned sharply eastward. Hurricane status was reached the next day as Emmy continued to the east.

Emmy's recurvature was very anomalous for this location and time of year. This behavior was caused by the development of strong upper-level westerlies across the central and eastern Atlantic and by an unseasonable frontal low-pressure system amplifying rapidly to the northeast of Emmy.

On August 27, a north-to-northeast course was resumed. The storm again turned eastward on the 29th at latitude 35°N and maintained this track for several days. A large number of ships passed rather close to the center of Emmy during this time period. Some were the PALMIRO TOGLIATTI, SEA MOON, STEPHANITOR, FALSTRIA, ALPHA GAS, FORT SAINTE MARIE, and ORE-JUPITER. The ORE-JUPITER was

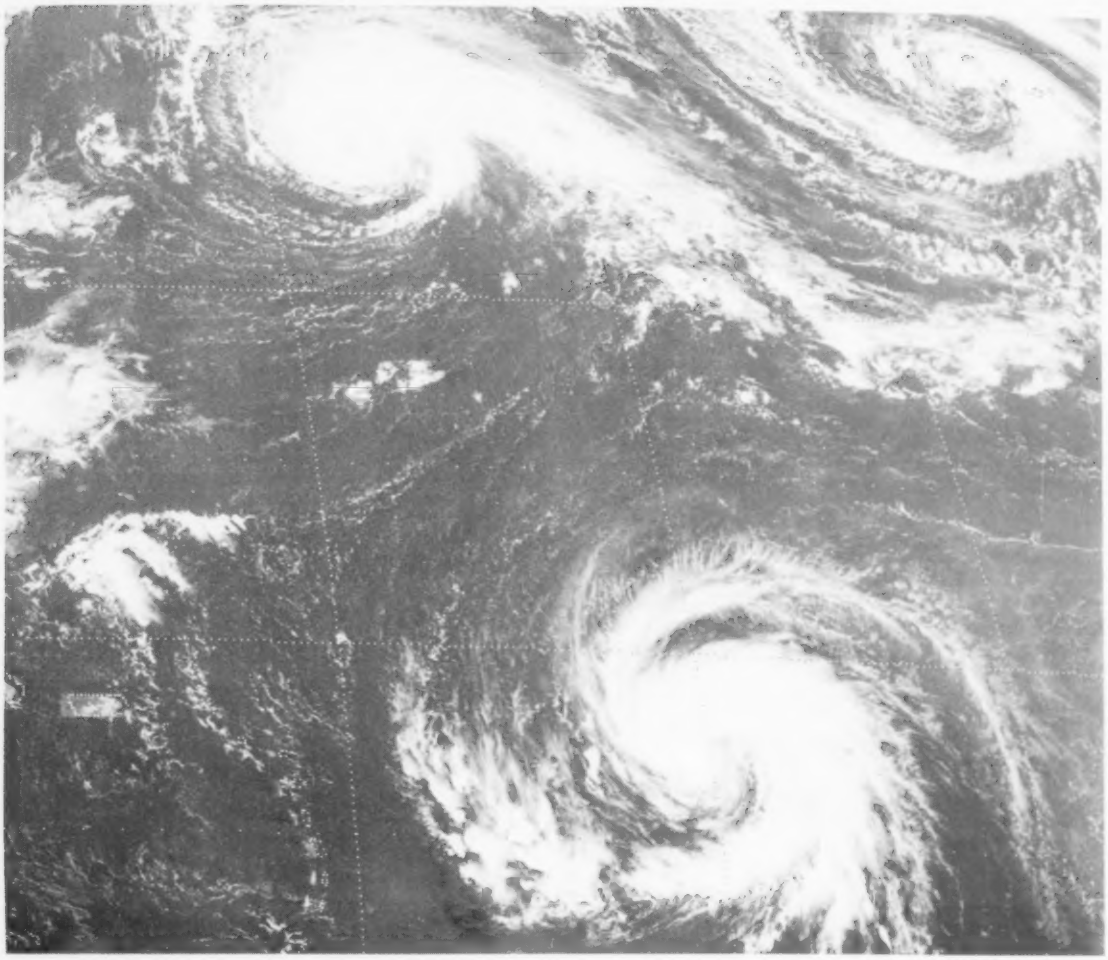

Figure 8.--Emmy (upper left) after recurvature and Frances (bottom) moving in the tradewinds. An extratropical storm is seen at upper right.

traveling northeastward toward the Azores and encountered Emmy's track several times during a 4-day period.

Maximum intensity was reached on the 29th when windspeeds hit 90 kn and the pressure fell to 974 mb. Figure 8 shows a satellite photograph of Emmy at this time.

The storm turned north on September 2 and crossed the Azores on the 3d. Emmy weakened as hurricane Frances approached and was absorbed by Frances' large circulation on the 4th.

A Venezuelan plane crashed at Lajes Airfield in the Azores during the height of Emmy's passage; 68 people were killed.

HURRICANE FRANCES, AUGUST 27 - SEPTEMBER 7

Frances followed a track across the central Atlantic similar to that of Emmy, with which it coexisted for 6 days. The initial depression moved west to northwest in the trade wind belt on August 27 and 28. The depression became a storm on the 28th as reconnaissance aircraft measured 50-kn winds. On the 29th, 50-kn winds along with 24-ft waves were confirmed by the HQUX, which was north of Frances.

By this time the storm had crossed about 1,000 mi south of Emmy and turned northward into the weak zone in the middle of the Bermuda-Azores high-pressure area left by the passage of Emmy (fig. 8).

Frances became a hurricane on August 30 and attained maximum intensity on September 1 with 100 kn and 963 mb central pressure. The hurricane continued to follow in the trough of Emmy and recurved toward the east. This too, except for Emmy, was unprecedented for the time and place. Weakening commenced as the storm headed toward the Azores. Satellite pictures suggest that it lost tropical characteristics by the 4th prior to crossing the islands.

The following ships reported gale-force or higher winds from both Emmy and Frances: HQUX, MINDEN, ORTECA, and ORE-JUPITER.

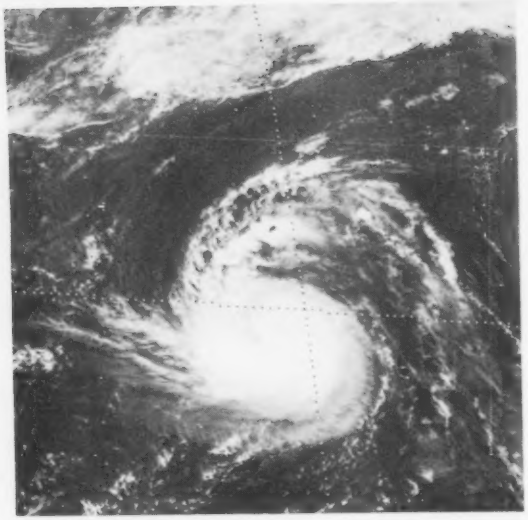

Figure 9.--Gloria 300 mi southeast of Bermuda on September 29.

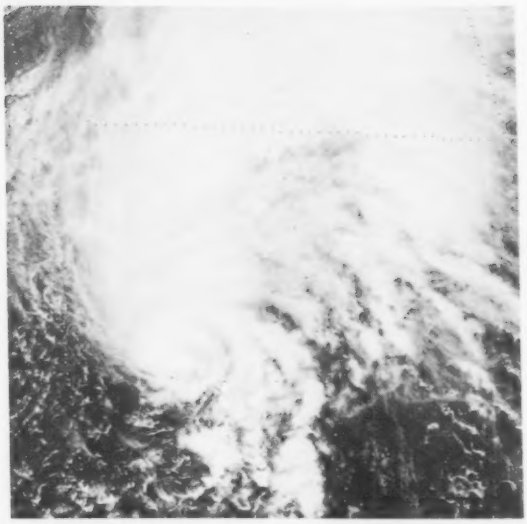

Figure 10.--A close-up of Holly on October 24 as a minimal hurricane.

HURRICANE GLORIA, SEPTEMBER 26-OCTOBER 4

The tropical depression which became Gloria formed 400 mi northeast of the Leeward Islands on September 26. The system moved northwestward and intensified. Tropical storm Gloria was named on the 27th, and it became a hurricane on the 29th. Figure 9 shows a satellite picture of Gloria on the 29th, 300 mi southeast of Bermuda and 12 hr prior to its maximum strength of 90 kn and 970 mb. Although this storm traveled across the central North Atlantic, only five ships reported gale-force winds.

Influenced by the westerlies, Gloria weakened for the next several days. Winds decreased to tropical storm strength on October 2, 600 mi south of Cape Race. Two days later, it became a depression and finally extratropical on the 5th just north of the Azores.

HURRICANE HOLLY, OCTOBER 22-28

Satellite pictures revealed an area of cloudiness 700 mi east of the Leeward Islands on October 20. After drifting westward, this cloud system became a tropical depression 2 days later. Now moving mainly northward, the depression intensified to a tropical storm on the 23d and to minimal hurricane strength on the following day (fig. 10). This intensity was maintained for only 24 hr, after which it weakened back to a tropical storm.

Holly remained a storm until merging with a strong cold front on the 28th. The lowest pressure was 990 mb and highest winds were 65 kn. Over a dozen ships reported gale-force winds, but none of these appeared to come very close to the storm's center. The JAPAN WISTERIA and EXPORT BUILDER were the only ships to report pressures less than 1010 mb.

SUBTROPICAL STORM NO. 1, MAY 21-25

On May 21, NOAA buoy EB04 and ship reports indicated that a low was forming in the middle Gulf of Mexico. This early season subtropical system strengthened to a storm by the 23d, with the KIEM, EXXON FLORENCE, and SOLON TRUMAN all indicating that this was indeed the case. The system crossed northern Florida and southeastern Georgia and passed into the Atlantic on the 24th. The storm merged with a frontal system a little more than 24 hr later.

The lowest pressure was 994 mb on the 24th off the coast of North Carolina with 45-kn winds. Tides up to 2 ft above normal occurred along portions of the Florida Gulf Coast. Damage was minimal, and rainfall was beneficial to the southeastern States as precipitation had been below normal.

SUBTROPICAL STORM NO. 3, SEPTEMBER 13-17

A low developed along a stationary front over central Florida on September 12. This low became a subtropical storm on the 13th as it passed off the coast just north of Jacksonville. After a short trajectory over water, the storm again touched the coast between Jacksonville and Savannah. A few ships reported gales during this brief period, with 39 kn reported by the RAVA-ROUSSKAYA. These winds were partially caused by a large high-pressure system to the north, which created a strong pressure gradient.

The storm was accompanied by heavy rains over portions of the Southeast. Tides were 2 to 3 ft above normal along the coast of the Carolinas. Damage was confined to minor beach erosion and local stream flooding.

WINTER OF EXTREMES AS VIEWED FROM NOAA SATELLITES

Richard M. Barazotto
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If you have been hibernating in a cave for the past 3 mo, you missed one heck of a winter. Record low temperatures in the eastern and midwestern United States have contributed to unusually heavy ice conditions on our nation's navigable waterways. From the Great Lakes to the Mississippi River to the Chesapeake and Delaware Bays, hazardous ice conditions have seriously impaired the commercial shipping and fishing industries. This year's heavy snow and ice cover has been pictorially preserved by NOAA-5, one of the National Environmental Satellite Service's (NESS) current operational satellites.

NOAA-5, a polar-orbiting satellite, is the latest in a series of Improved TIROS Operational Satellites (ITOS). NOAA-5's orbit altitude is approximately 1,400 km, and it makes two passes a day over a given area at approximately 9:00 a.m. and 9:00 p.m. local time. The instrument on board NOAA-5 used for snow and ice monitoring is the Very High Resolution Radiometer (VHRR), which is sensitive to visible radiation of wave length .6 to .7 micrometers and thermal infrared radiation of wave length 10.5 to 12.5 micrometers. The resolution of VHRR data is 1 km at nadir. Due to insufficient sunlight, visible data cannot be obtained from the 9:00 p.m. pass; however, infrared data are received from both daily passes. Unless otherwise stated, all pictures in this article are visible VHRR images.

Figure 11 shows the U.S. East Coast as it appeared on January 29, 1977. Ice has begun to form in Long Island Sound and already covers much of the Delaware and Chesapeake Bays. Figure 12 depicts the East Coast as it appeared on January 31, 1977, merely 2 days later. As can be seen, Long Island Sound is now completely covered with ice.

Navigation on the Chesapeake Bay was hampered this year by extensive ice cover (fig. 13). The Chesapeake Bay north of the Bay Bridge was closed to navigation on February 2, and the Chesapeake and Delaware Canal was forced to close for the first time in history. In figure 12, notice the bright white band of ice lining the eastern shore of Chesapeake Bay. This thick accumulation of ice has been pushed against the eastern shore by strong westerly winds and has hampered oyster boats and oil tankers alike. Statistics released by the Fisheries Administration of the Maryland Department of Natural Resources reveal that only 39,331 bushels of oysters were taken from the Bay in January of this year compared to 285,686 bushels in January 1976. Needless to say, this reduction in the

Figure 11.--The U.S. East Coast as it appeared on January 29, 1977. Ice has started to form along the southern shore of Long Island Sound.

Figure 12.--Just two days later, on January 31, the satellite shows a dramatic build up of ice on Long Island Sound.

Figure 13.--One of the many bulkcarriers waiting in the ice off Hampton Roads owing to delays in loading as the coal was frozen in the railroad cars. Wide World Photo.

size of the oyster catch has meant unemployment for many of Maryland's oystermen.

Eastern Shore communities have been running very low on heating fuel as a direct consequence of the ice conditions. For example, Salisbury, Md., usually receives winter supplies of heating oil by way of barge convoys which can normally sail unimpeded up the Wicomico River. This year, Coast Guard-assisted convoys have been unable to regularly make the trip up the ice-clogged river resulting in a dangerous depletion of heating oil reserves.

Normal commerce on the Great Lakes has also been interrupted by this year's heavy ice cover. Iron ore trade on Lake Superior had to be halted for the first time in 3 yr. Figure 14a, taken by NOAA-4 (NOAA-5's predecessor), shows the Great Lakes as they appeared on February 21, 1975. As can be seen from this image and the accompanying analysis (fig. 14b), several of the lakes are virtually ice free. Lake Erie, the shallowest of the five, is the only lake exhibiting a significant ice cover. Green Bay, Saginaw Bay, Whitefish Bay, and the Straits of Mackinac are a few of the areas which are 100 percent ice covered. Compare this picture and analysis to figures 15a and 15b for February 7, 1977. For all practical purposes, the Lakes are completely ice covered with the exception of Lake Ontario. As with the Chesapeake Bay, the eastern shores of Lakes Michigan and Huron show thick accumulations of wind-blown ice. In the 4 yr that NESS has been monitoring ice cover on the Great Lakes, this is by far the heaviest ice condition ever observed.

Frank Quinn of NOAA's Environmental Research Laboratory in Ann Arbor, Mich., had predicted that Lake Michigan would completely freeze over this year--an occurrence not observed for the past 2 decades. Quinn made his comments in a NOAA NEWS article dated February 4, 1977. Three days later, the sensors on board NOAA-5 revealed the accuracy of his prediction (fig. 15a).

In figure 15a, the letter "X" marks the position of St. Louis, above which can be seen the confluence of the frozen Missouri, Mississippi, and Illinois Rivers. Barge traffic along the Mississippi between St. Louis and Cairo, Ill., has been seriously impaired as a result of this year's unusual ice cover (fig. 16).

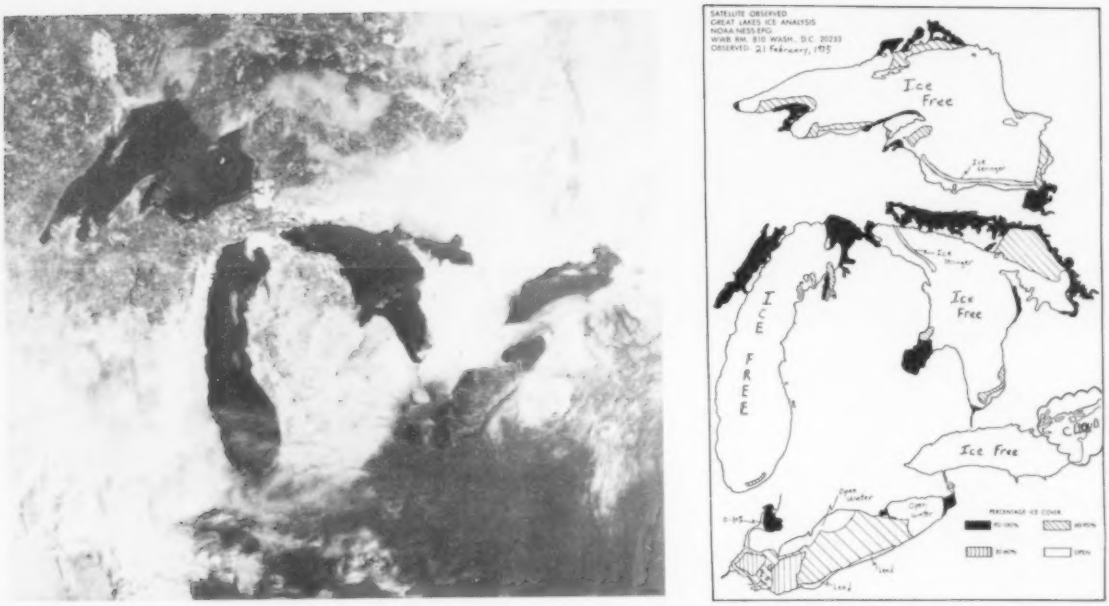

Figure 14a. and b. --The left photograph shows the satellite image of the ice on the Great Lakes on February 21, 1975. On the right is the analysis made from the image.

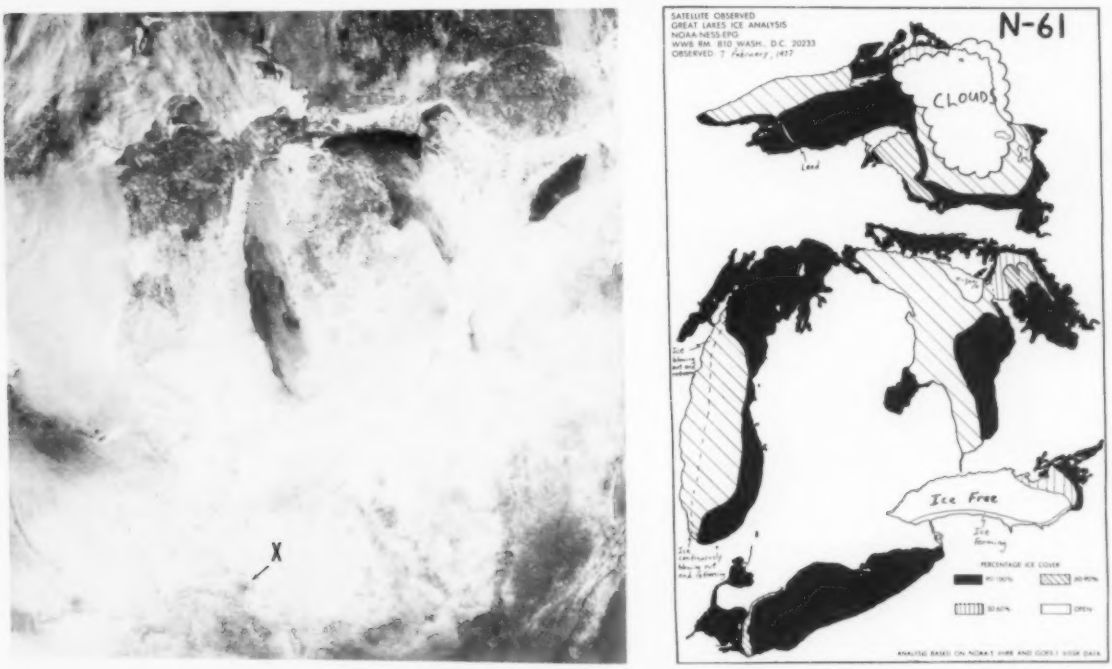

Figure 15a. and b. --This satellite image and analysis for February 4, 1977, show the much more extensive ice cover this year. The "X" marks the location of St. Louis and the confluence of the frozen midwestern rivers. The area north of the Ohio River is completely snow covered.

Figure 16.--Tugboats rammed their way through a 10-ft-thick wall of ice on the Ohio River on January 26 until they cleared a channel 300 ft wide. Low water levels in addition to the ice made navigation hazardous for river traffic. Wide World Photo.

It is also interesting to note in figures 14a and 15a the comparative snow cover for the respective days. On February 21, 1975, in the Midwest, the southernmost limit of the snow pack was confined to northern Illinois and Indiana, with Ohio almost snow free. On February 7, 1977, the snow cover extended as far south as Kentucky, with Ohio completely snow covered.

As severe as the ice and snow conditions have been in the East and Midwest, there are parts of the country deeply concerned over a lack of snow. The Pacific Northwest has been experiencing a very mild winter with little attendant snow fall. Figures 17 and 18 depict the Cascade Mountains in Oregon as they appeared on January 28, 1976, and January 27, 1977, respectively. In figure 17 snow covers much of the western slopes of the Cascades; however, in figure 18 the snow pack is all but absent, except for a few isolated glacial peaks. Unlike the preceding images, these two were taken from SMS-2, NESS's West Coast geostationary satellite. SMS-2 is stationed over the Equator at 135°W at an altitude of approximately 36,000 km. The primary sensor on board SMS-2 is the Visible and Infrared Spin Scan Radiometer (VISSR), which is sensitive to

Figure 17.--The mountains of the Cascade Range with extensive snow cover on January 28, 1976.

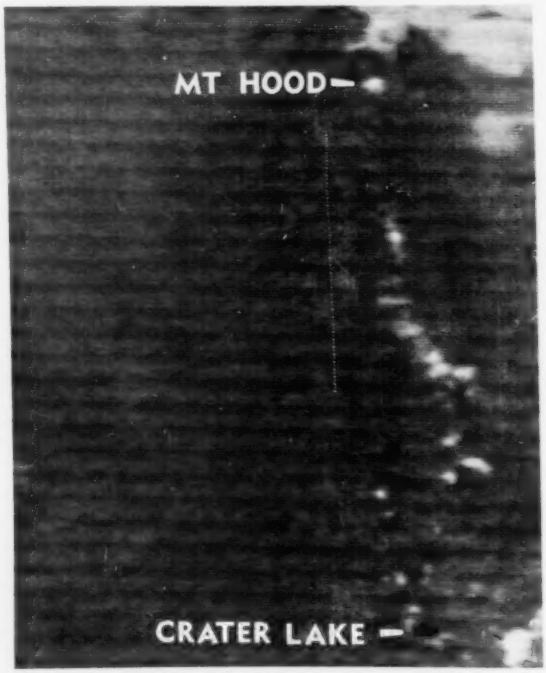

Figure 18.--The same area of the mountains this year on January 27, 1977, with snow showing only on the glacial peaks.

visible radiation of wave length .54 to .70 micrometers and infrared radiation of wave length 10.5 to 12.6 micrometers. The resolution of VISSR is approximately 1 km for visible data and 8 km for infrared data.

The extent of snow cover in the western United States, as observed from satellite, was much below normal for that time of year. This confirmed data coming in from the field indicating a very shallow snow pack. The result of such a depleted snow pack could be severely diminished water supplies for irrigation, hydroelectric power generation and personal consumption.

In this unusual winter there has been a great demand for satellite support as an aid in environmental monitoring. The Great Lakes Ice Analysis in the figures is but one example of the many satellite-derived analyses that NESS produces. For information concerning the kinds of products and data that are available, write to Russell Koffler, Environmental Products Group (S126), National Environmental Satellite Service, NOAA, Washington, D.C. 20233.

POSSIBLY COLDEST WINTER ON RECORD

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This heating season (October 1976 through January 1977) was a record-breaker or near record-breaker throughout most of the Plains States and the eastern United States. January was colder than any January in the record books (fig. 19). Cincinnati, one of the most striking examples of the really bitter cold, had an average temperature of 12°F during January--20°F below normal and over 4°F below the previous record of 1918. The October through January average for Cincinnati was also the lowest since records were begun in 1873. While misery was widespread, it was not universally extreme. Albany, N.Y., with a mean of 15.5°F for January 1977 was only 6°F below normal; January has been colder 10 times since 1873.

So far, this winter has indeed been one for the history books. Just how unusual was the season when considered over a span of several generations? A preliminary study underway at the National Climatic Center in Asheville, N.C., indicates that through January the season has been an overall record-breaker, going back to about 1800. There have been similar, but somewhat milder cold spells, most notably in 1917-18. The October through January 1976-77 season was only slightly colder than 1917-18 records, and may not be what is termed "significantly different" in a statistical sense. However, February 1918 appears to have been slightly warmer than average with March considerably warmer than average. Thus, if the National Weather Service extended outlook for below average February temperatures in the Plains states and the East are verified and, further, if March is anywhere near normal or colder, then this season may well wind up being unprecedented since the founding of the Republic.

In contrast, similar studies of the warm winter of 1931-32 indicate it is probably unequalled for its warmth. In fact, it seems to have been a much rarer event in terms of mildness than this season has been in terms of cold.

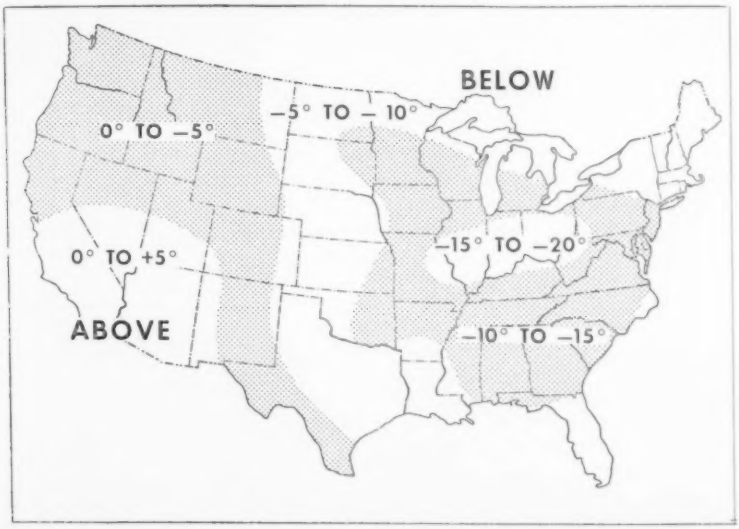

Figure 19.--Departure of average January 1977 temperatures from 1941-70 normal. (Based on preliminary information from the Environmental Data Service's National Climatic Center.)

ICE CONDITIONS ON THE HUDSON RIVER

Walter J. Stoddard
National Weather Service, NOAA
New York, N.Y.

This winter, December and January were the third coldest on record according to data taken at the National Weather Service Forecast Office in New York City. Statistics from the Climatic Section of the New York Forecast Office show that December 1917 and January 1918 still rank as the coldest at that observation site (table 7).

Table 7.--Mean temperatures for the four coldest December and January at New York City

Year	December	January	Mean
1917-18	25.0°F	21.7°F	23.4°F
1881-82	26.5°F	24.7°F	25.6°F
1976-77	29.9°F	22.1°F	26.1°F
1877-78	24.9°F	27.7°F	26.3°F

According to the U.S. Coast Guard, there was pack ice on the Hudson River from New York to Poughkeepsie which was particularly heavy in the Tappan Zee section (fig. 20). From Poughkeepsie to Castleton-on-Hudson, there was solid 12-in ice, and from there to Albany thin ice (fig.21).The thin ice on the more northern part of the river resulted from warm water that factories in the area empty into the river, which causes the water temperature to rise. North of Albany, the ice was solid and thick.

With the help of the Coast Guard cutter MAINTOW vessel traffic managed to keep a channel open from New York Harbor to Albany. The vessels are mainly of the ocean type with enough power to break the ice and maintain the channel. During the winter of 1960-61, the Coast Guard ran convoys up the Hudson River when the channel closed.

Figure 20.--In addition to icebreaking duties, these Coast Guard men were shoveling snow off the deck.

The Sandy Hook Channel to Arthur Kill and Kill van Kull was open to daylight navigation only since a number of buoys were out of position. Shipping was hampered by heavy ice accumulation in the Sandy Hook Bight.

A major problem for the Coast Guard and ships was the shifting of buoys out of position by the ice (cover). This is a frequent occurrence with thick, moving ice, which could result in vessels going aground.

Figure 21.--A man walks from the oil tanker TEXACO WISCONSIN on the frozen river near Hudson, N.Y. He is from a local power boat association bringing supplies to tugs, working to free more than six ships jammed in 3 ft of ice. Wide World Photo.

SEVERE WEATHER HALTS MOST GREAT LAKES TRAFFIC

Elwyn E. Wilson
Environmental Data Service, NOAA
Washington, D.C.

The Great Lakes shipping industry informed the Chairman of the Winter Navigation Board on January 17, 1977, that worsening ice conditions and continuing severe weather conditions in Lake Superior and the St. Marys River warranted a temporary suspension of vessel traffic in that portion of the Great Lakes and St. Lawrence Seaway System. The Board concurred in the action.

Several factors had to be considered by the Board, which is responsible for the Great Lakes Winter Navigation Program, before reaching this decision. These included increasing difficulty in providing unimpeded island transportation, ice severity, increasing difficulty in getting vessels through the system, and indications of continuing subzero temperatures. Although these problems had been overcome thus far, increasing needs were taxing the facilities and systems available in the demonstration mode.

In addition, the continued cold weather was taxing energy consumption within the region, and unusual demands were emerging for Coast Guard icebreaking assistance, vital to vessel operations, on a priority basis elsewhere in the Great Lakes.

Other activities not involving shipping operations continued as scheduled. These include observation, surveillance, data collection on the St. Marys River and in other parts of the system, continuing effort on environmental studies and base data determination, economic studies, and simulation model studies.

All ships in the Lake Superior-St. Marys River portion of the system were cleared. Cessation of traffic in the St. Marys River did not affect other vessel operations in the Lakes. Should ice severity lessen and weather conditions moderate, consideration will be given to resumption of vessel traffic on the St. Marys River, provided that industry desires and is able to resume.

Coast Guard crews worked to free the 5,443-ton Great Lakes tanker AMOCO INDIANA, which was ice bound and aground off Northport Point, north of Traverse City, Mich. The 10,294-ton Great Lakes bulk-carrier BENJAMIN F. FAIRLESS was stranded in ice on Lake Superior off Devils Island along with three others off Whitefish Point. Three ships were also ice bound in the St. Marys River. All were freed by the Coast Guard. Thickening ice was threatening to bring shipping to a complete halt.

Note: A late report from New York City indicated that the average temperature for this season's winter months of December, January, and February was 28.5°F. This makes the 1976-77 winter for New York City the coldest in the past 41 yr and the 10th coldest in the 108 yr that weather records have been kept.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

GUAM AS A TYPHOON HAVEN

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and Jack W. Blelloch
Naval Environmental Prediction Research Facility
Monterey, Calif.

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

Editor's Note: This is the first in a series of articles evaluating the safety of ports as shelters from tropical cyclones. These are edited versions of studies that appear in the Typhoon Havens Handbook for the Western Pacific and Indian Oceans by Samson Brand and Jack W. Blelloch, June 1976, Naval Environmental Prediction Research Facility, Monterey, Calif.

The old maxim "any port in a storm" was never uttered by a weatherwise mariner.

On May 20, 1976, supertyphoon Pamela ravaged Guam with 120-kn sustained winds that gusted to 165 kn (fig. 22). About one-half of the buildings on the island were destroyed, and three ships were driven aground. It was the worst storm to hit Guam since Karen brought 130-kn winds in November 1962 when three ships were sunk in Apra Harbor and two tug boats and a huge floating crane were driven ashore. About 95 percent of the buildings on the island were damaged or destroyed during Karen.

There are no aspects of Apra Harbor that recommend it as a typhoon haven. The surrounding topo-

Figure 22.--This building on Andersen Air Force Base, Guam, withstood the strong winds from Pamela better than the palm trees and panel truck which overturned. U.S. Air Force Photo.

Figure 23.--Topographical map of Guam.

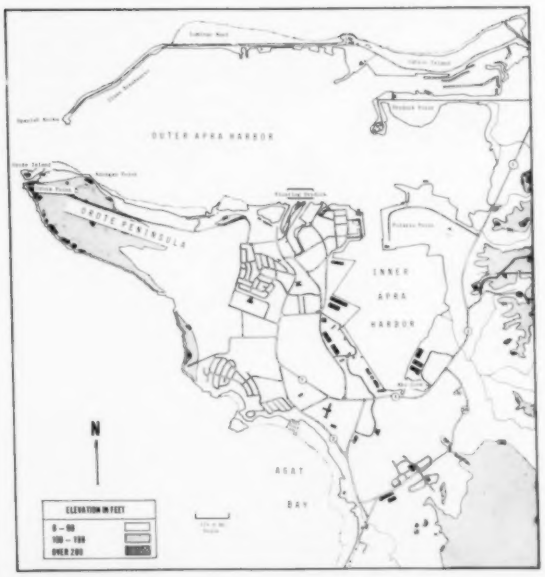

Figure 24.--Apra Harbor.

graphy is low and does not provide an extensive windbreak. The harbor entrance is open to the west and in close proximity to the berths and moorings in the outer harbor. Consequently, westerly winds and seas associated with a typhoon passage have a devastating effect within the harbor.

THE SETTING

Guam, the southernmost island in the Mariana Islands group, is located approximately 1,300 mi east of the Philippines. It is a relatively flat island with only a few points reaching over 1,000 ft above mean sea level (fig. 23). Agana is the capital city of Guam and Apra Harbor is its port. While other anchorages are available, Apra Harbor is the commercial port for Guam as well as the major transhipment port for the Pacific Island Trust Territories. A detailed study of the coast and bays of Guam is included in the Defense Mapping Agency, Hydrographic Center's Sailing Directions, H.O. Pub. No. 82, The Pacific Islands, Volume 1.

Apra Harbor, which consists of an inner and outer portion, is an improved natural harbor located on the southwest coast of the island (fig. 24). Orote Peninsula projects 3.5 mi northwestward from the coast and forms the southern boundary of the harbor, which is bounded on the north by a breakwater that is partially manmade and extends 15 ft (average) above mean sea level (fig. 25). The entrance to the harbor is 500 yd wide and over 100 ft deep. The vast harbor contains a substantial number of mooring buoys and piers. The outer portion affords a large number of deepwater anchorages, and the holding capability is considered excellent. However, it also contains several shoal and reef areas that, while clearly marked, must be a major consideration should maneuvering be required during periods of heavy weather. The low hills to the east of the harbor provide a windbreak to easterly winds. However, Apra Harbor should by no means be considered a sheltered port.

THE CLIMATOLOGY

Western North Pacific tropical cyclones can occur during any month. However, most of those that "threaten" Guam occur from June through December (fig. 26). For the purposes of this study, any tropical cyclone approaching within 180 mi of Guam is considered a threat. The study period is June through December for the 27-yr period 1947-73.

During the study period, 107 tropical cyclones (about four threats each year) passed within 180 mi of Guam. A number of years had as many as seven tropical cyclone threats. Only eight of the tropical cyclones brought gales (winds $\geq$ 34 kn) to Guam[1], and four of these occurred in November (fig. 27). About 50 percent of the storms reached tropical storm intensity after passing the closest point of approach (CPA) to Guam. Many reached tropical storm or typhoon strength west of Guam (figs. 28 and 29).

Of the 107 tropical cyclones that were a threat to Guam, about 60 percent passed to the north and 40

[1]Wind information is based on hourly wind observations from Naval Air Station, Agana, which are felt to be representative of the winds experienced in Apra Harbor.

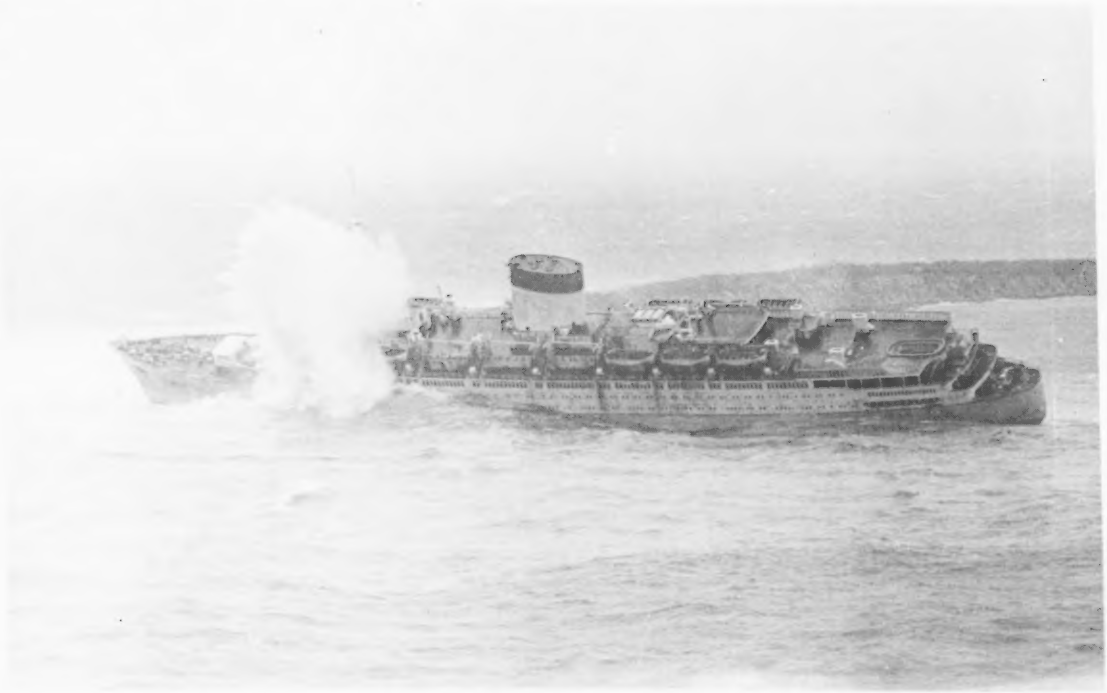

Figure 25.--CARIBIA (40,000-ton passenger liner) being towed to Taiwan. The sea and swell associated with tropical storm Mary (August 1974) caused enough difficulties that the ship had to be released from tow and went aground on the Glass Breakwater off Apra Harbor and sank. She had to be salvaged.

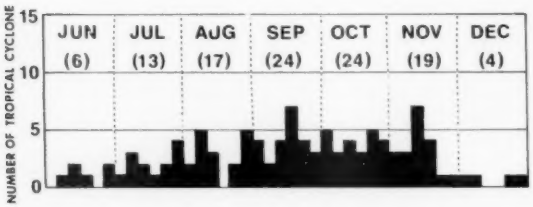

Figure 26.--Frequency distribution of the number of tropical cyclones that passed within 180 mi of Guam (June - December, 1947-73). Subtotals are based on 5-day periods and the numbers in parentheses are the monthly totals.

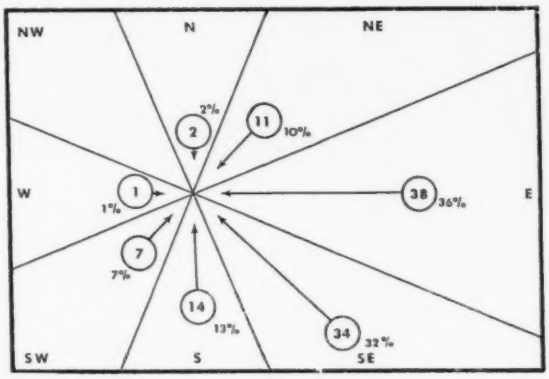

Figure 27.--Direction of approach to Guam of tropical cyclones (June - December, 1947-73) which passed within 180 mi of Guam. Circled numbers indicate the number that approached from each octant. The other numbers are the percentage of the total sample (107) that approached from that octant.

percent to the south. In general, however, there were more strong wind situations for storms passing to the south, since this places Guam in the high wind or dangerous semicircle. A number of storms continued to generate strong winds on Guam at distances of 200 mi or more to the west and south.

Figures 30 through 36 show the percentage of tropical cyclones, at various distances, that have moved within 180 mi of Guam from June through December. This can be interpreted as a probability of a threat. The dashed lines represent approximate approach times to Guam based on an approach speed of 8 to 12 kn. For example, in figure 30 a storm at 8°N, 150°E, has an 80-percent chance of passing within 180 mi of Guam; if its speed is in the 8- to 12-kn range, it will reach the island in about 1-1/2 to 2 days.

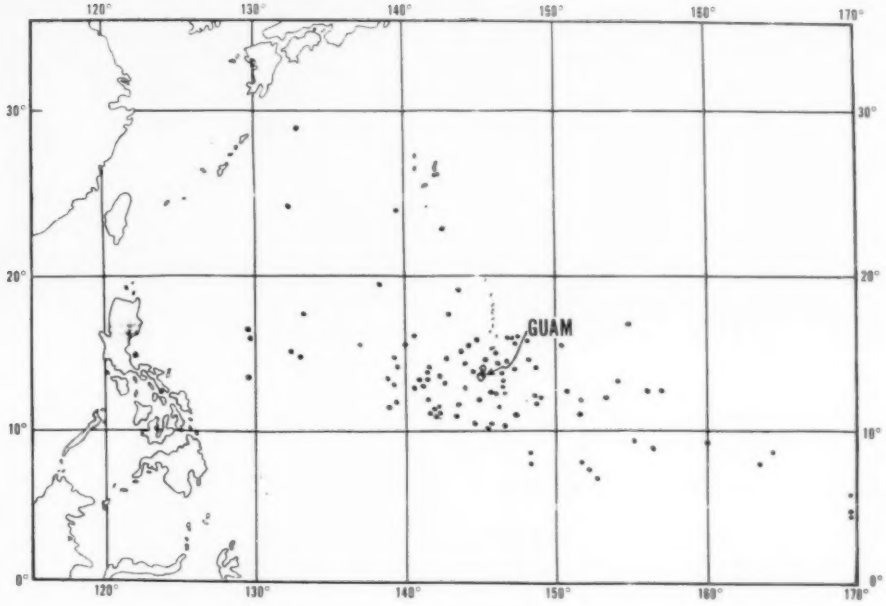

Figure 28.--Initial point of attainment of tropical storm intensity (≥34 kn) for 107 tropical cyclones passing within 180 mi of Guam (June - December, 1947-73). Since seven tropical depressions did not achieve the above criteria, only 100 positions are plotted.

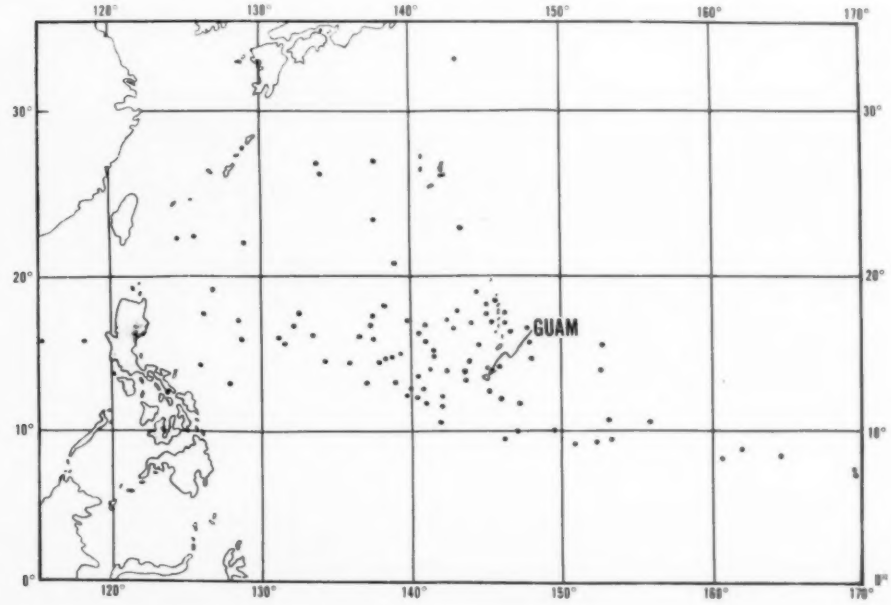

Figure 29.--Initial point of attainment of typhoon intensity (≥64 kn) for 107 tropical cyclones passing within 180 mi of Guam (June - December, 1947-73). Since 16 tropical cyclones did not achieve the above criteria, only 91 positions are plotted.

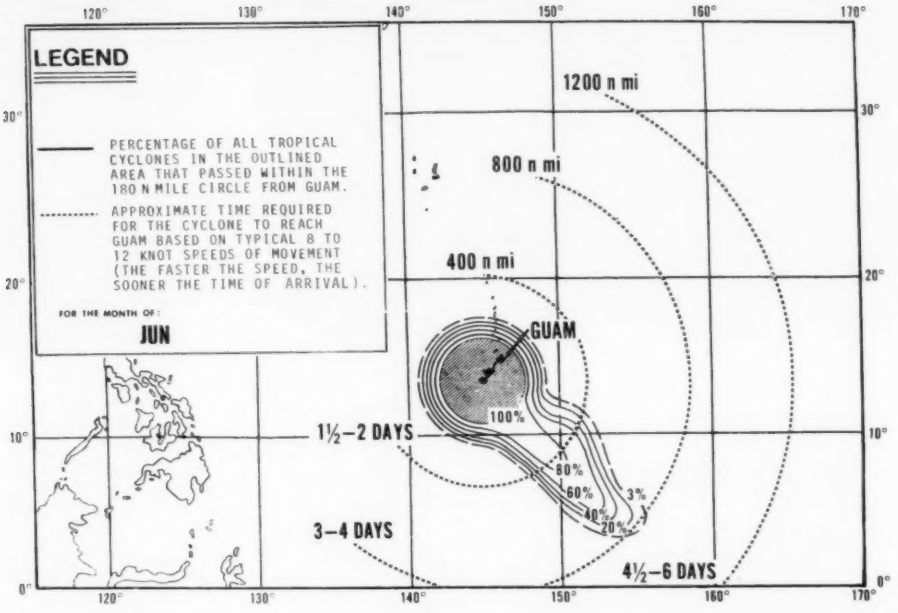

Figure 30.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of June (based on data from 1947-73).

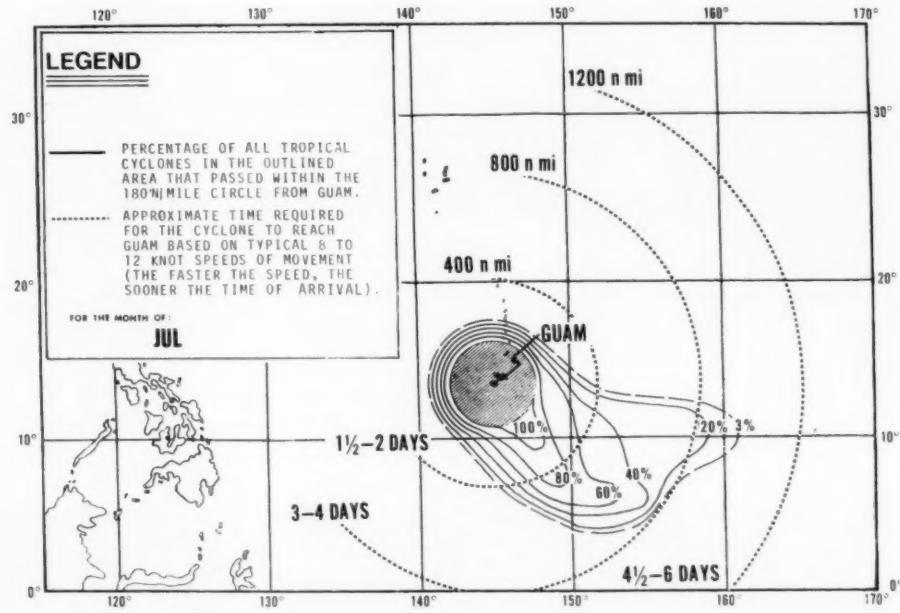

Figure 31.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of July (based on data from 1947-73).

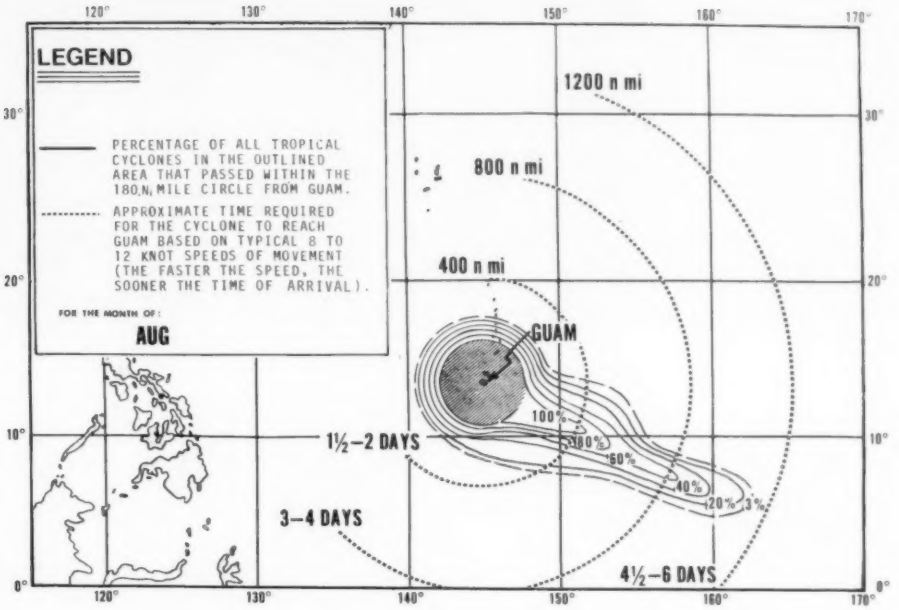

Figure 32.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of August (based on data from 1947-73).

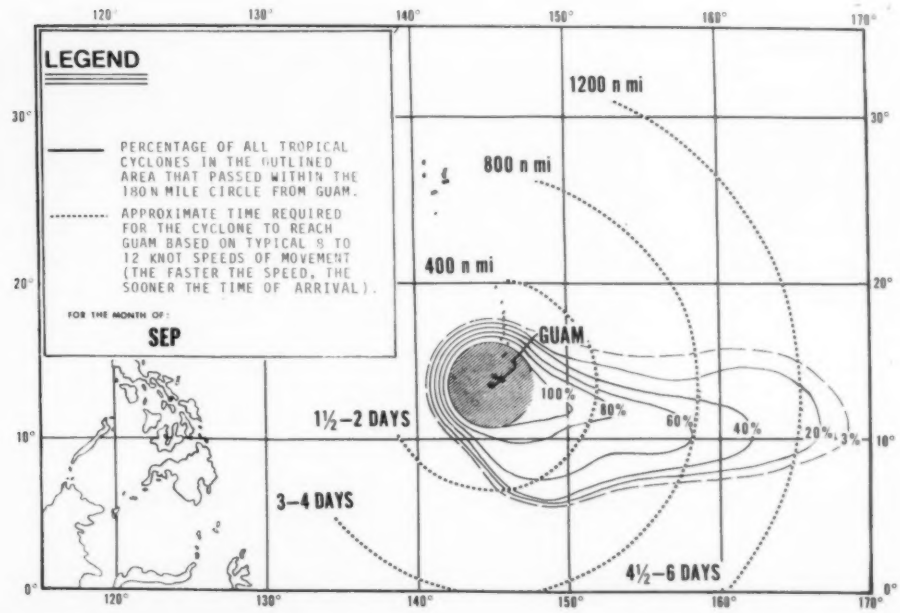

Figure 33.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of September (based on data from 1947-73).

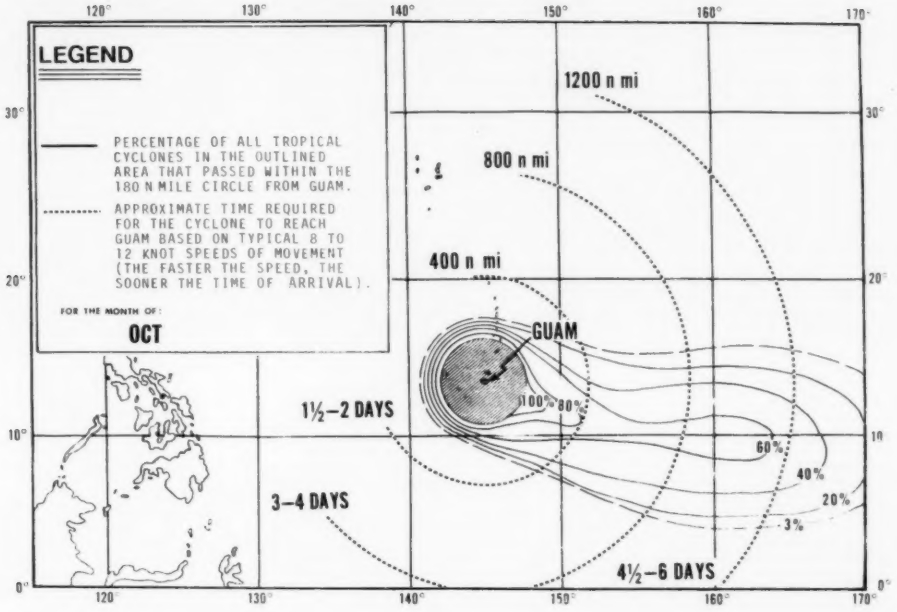

Figure 34.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of October (based on data from 1947-73).

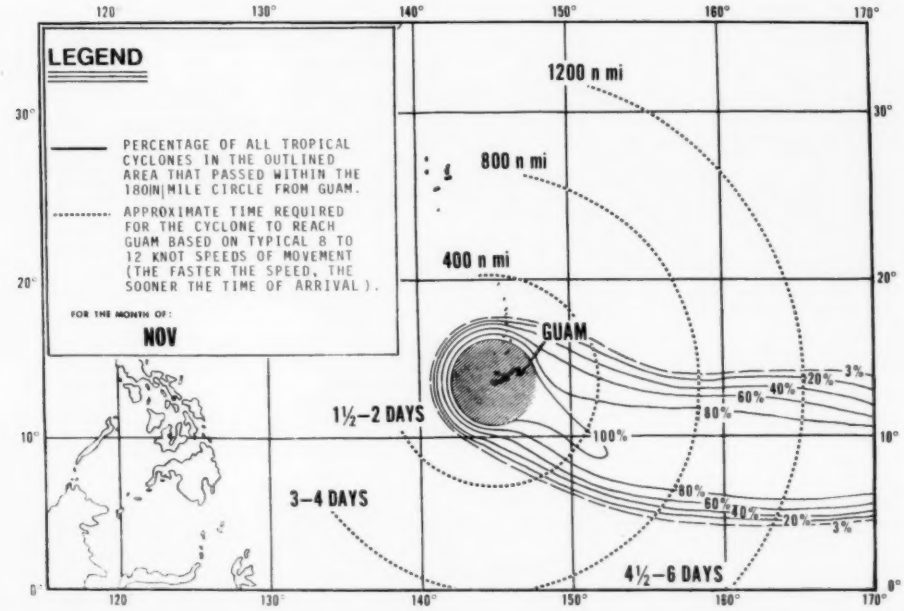

Figure 35.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of November (based on data from 1947-73).

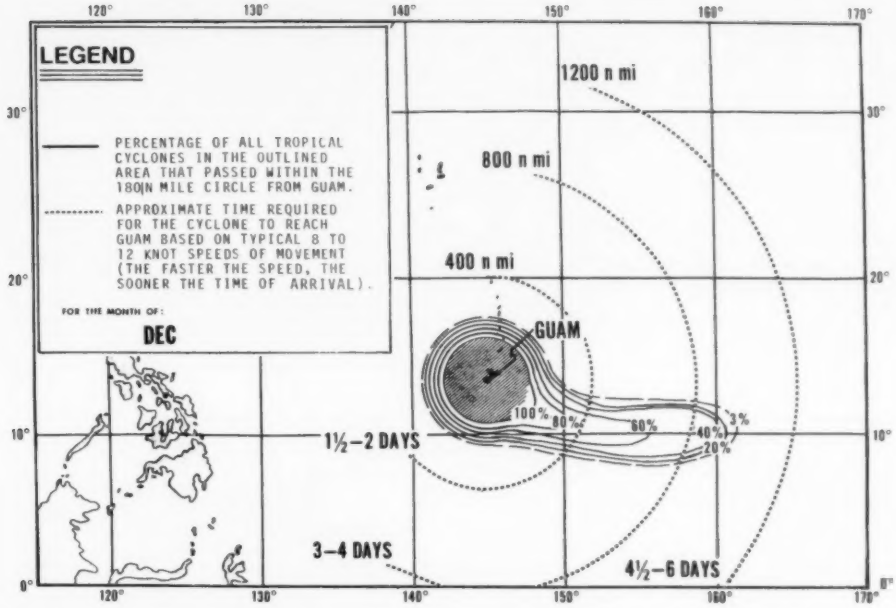

Figure 36.--Probability that a tropical cyclone will pass within 180 mi (shaded circle) of Guam for the month of December (based on data from 1947-73).

THE PROBLEM

Although just eight tropical cyclones generated gale-force winds on Guam in the 27-yr study period, this is significant if you view the tropical cyclone as a rare event. Five tropical cyclones were classified as supertyphoons (winds $\geq$ 130 kn) within 180 mi of Guam, and gusts of 100 kn or more occurred three times on the island during the study period. Sudden intensification is another headache. A tropical cyclone in the vicinity of Guam will intensify 15 to 20 kn within 24 hr on the average, but there is also a 5- to 10-percent chance that the storm will intensify by 40 to 50 kn within 24 hr.

Because of its extensive area and limited sheltering topographical features, Apra Harbor is subject to severe wave action when a tropical cyclone passes. Wave heights are primarily a function of windspeed, fetch, and duration. Since Apra Harbor is open to the west, those storms that result in a westerly wind field over Guam expose the harbor entrance to severe wave action. In the outer harbor waves of 6 to 10 ft are "common" during storm passage. It is possible that maximum wave heights could exceed 20 ft under a westerly wind field of typhoon intensity. These waves build before local wind conditions become strong and may continue high after the winds abate.

Storm surge is also a problem in Apra Harbor. Typhoon conditions have created surges 10 to 12 ft above mean lower low water level.[2] At the northern tip of Guam surges of 18 ft have been recorded. Obviously, these extreme changes in water level must be taken into account when planning for heavy weather situations.

[2]A tidal datum. The arithmetic mean of the lower low water heights of a mixed tide observed over a specific 19-yr Metonic cycle. Only the lower low water of each pair of low waters of a tidal day is included in the mean.

THE DECISION

Historically, tropical cyclones have approached Guam from all directions. Since most are in the developing stages, their movement as well as intensity and wind distribution are very difficult to forecast. This makes long-range evasion planning very difficult. However, some rough guidelines which might be useful are presented in conjunction with figure 37.

1. An existing tropical cyclone moves into or significant development takes place in area A; forecasted movement is toward Guam:

   a. Review material condition of ship. Evasive action may be desirable in 2 to 4 days.
   b. Reconsider any maintenance that would render the ship incapable of getting underway within 48 hr.

2. Tropical cyclone moves into or significant development takes place in area B; forecasted movement is toward Guam:

   a. Evasive action may be necessary within 2 days.
   b. Reconsider any maintenance that would render the ship incapable of getting underway within 24 hr.

3. Tropical cyclone enters area C moving toward Guam:

   a. Consider immediate evasive action.

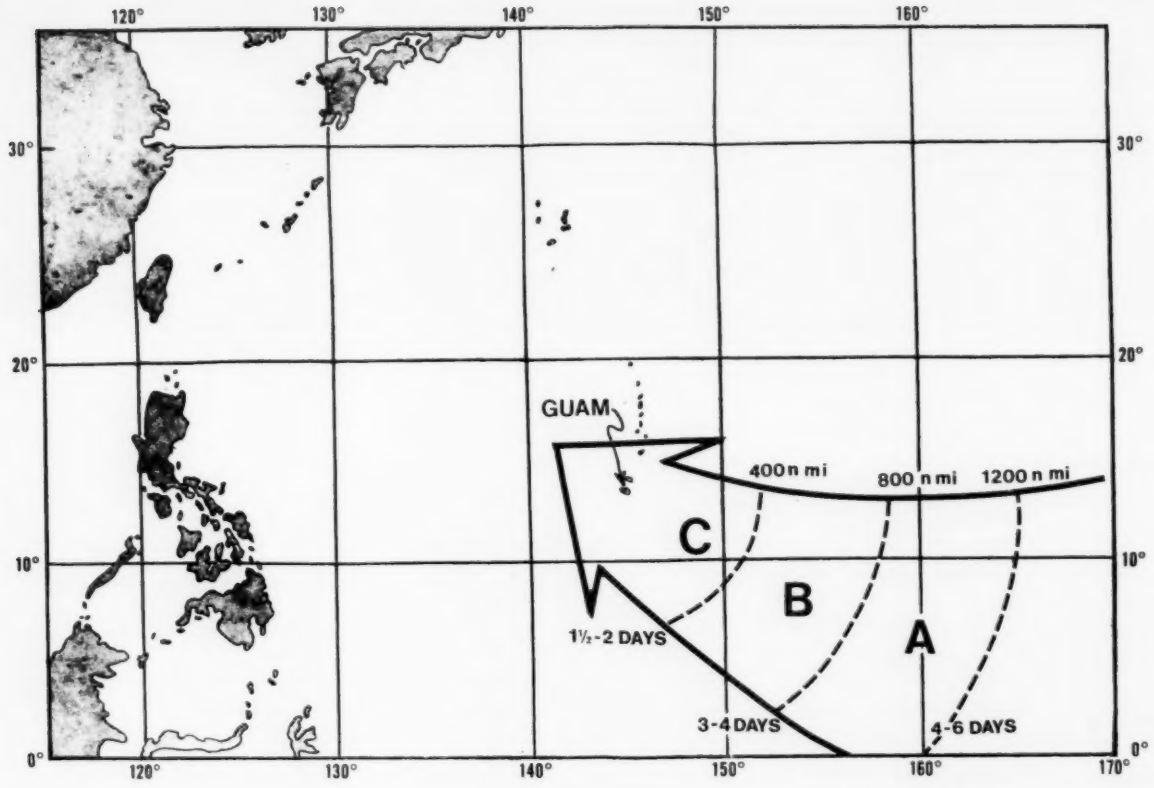

Figure 37.--Tropical cyclone threat axis for Guam. Distances and approach times are measured from Guam based on an 8- to 12-kn speed of movement.

Because of its lack of natural protection, Apra Harbor provides little or no haven qualities. As a result, remaining in port is not recommended when typhoon conditions threaten. Remaining in port poses the problem of deciding on and then requesting the "best" possible mooring location. Such a location would be a function of ship type, expected sea state, wind, and time available for the move. Based on limited past experience, a general rule for winds up to 50 kn would be: "Obtain an inner harbor berth as close to the upwind shore as possible." Any ship subjected to high winds while moored will take some beating, but this rule should minimize the damage sustained.

Weather warnings concerning Guam and the Pacific Island Trust Territories are based on information gathered at Fleet Weather Central/Joint Typhoon Warning Center, Guam (FWC/JTWC). All information and warnings are then broadcast from Guam on the appropriate frequencies as listed in the Worldwide Marine Weather Broadcasts published jointly by the National Weather Service and the Naval Weather Service Command. In addition, warnings are broadcast on Apra Harbor Control Frequency 2716 kHz and Tug Control Frequency 3216 kHz during typhoon and tropical storm conditions.

THE EVASION

Evasion at sea is the preferred course of action when confronted with potential typhoon conditions at Guam. The following evasion techniques are suggested for the more common "threat" situations.

1. Tropical cyclone approaching from the east or southeast; forecast to pass north or within 60 mi south of Guam:

   a. Evasion should be toward the southwest. The ship will be in the safe or navigable semicircle with following wind and sea.

2. Tropical cyclone approaching from the east or southeast; forecast to pass more than 60 mi south of Guam:

   a. Evasion should be toward the northeast.

3. Tropical cyclone approaching from the south; forecast to pass east of Guam:

   a. Evasion should be toward the west-southwest.

4. Tropical cyclone approaching from the south; forecast to pass west of Guam.

   a. Evasion should be toward the east-southeast.

Crossing ahead of an approaching storm as recommended in 1. above is not without hazard and must be accomplished well ahead of the typhoon. In attempting this track crossing, if the ship is caught in the sea and swell pattern ahead of the storm, the speed of advance may be reduced to the point that the ship will be unable to maneuver clear of the storm. It is also very possible during the peak of the typhoon season for a number of tropical cyclones to coexist in the western North Pacific. This occurs approximately 50 days each year. This possibility would greatly complicate the evasion problem and should be kept in mind when evasion plans are formulated and executed.

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Holliday, C.R., Tropical Cyclones Affecting Guam, Fleet Weather Central, Guam Tech. Note JTWC-75-3, 1975.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Hints to the Observer

PROBLEMS WITH 0000 HOUR ON SHIP'S WEATHER OBSERVATIONS FORM

There have been some problems in filling in the "day" and "00" hour under columns 5 (YY) and 6 (GG) on the Ship's Weather Observations form 72-1 since synoptic hours are no longer preprinted on the form. One common error is ending the day with 2400 hr, such as "03/24"; it should read "04/00." Another common error is using the previous day with the 0000 hr, such as "03/18, 03/00, 04/06" instead of "03/18, 04/00, 04/06."

See figure 40 for examples of common errors and correct format. These time errors can result in the loss of the observation during computer processing. It could be rejected as containing an error or for the wrong time for the chart. In any case, the observation would require special evaluation for validity.

99	$L_aL_aL_a$	Q_c	$L_oL_oL_oL_o$	YY	GG		YY	GG
99				03	12		03	12
99				03	18		03	18
99				03	24	Change to →	04	00
99				04	06		04	06
99				04	12		04	12
99				04	18		04	18
99				04	00	Change to →	05	00

Figure 38.--Common time-date errors with corrections.

Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

Beginning January 1, 1977, several changes have occurred in marine weather communications. For the coastal and offshore mariner, the long expected shift to single sideband has arrived along with the discontinuance of the AM transmissions. The high-seas radiotelegraph weather broadcast for the Atlantic Ocean also saw some changes. Radio station NAM, Norfolk, Va., is once again keying this broadcast with simultaneous transmission from Key West, Fla.; Athens, Greece; Thurso, Scotland; Rota, Spain; and Reykjavik, Iceland. This is the revised schedule:

Broadcast time (GMT)		Content
0030 to 0115	NWS	Western North Atlantic warnings and coded analysis
0630 to 0715	NWS	Western North Atlantic warnings and forecasts
0800 to 0900	FWC	Norfolk/Rota NORLANT/EASTLANT/MED weather
1230 to 1300	NWS	Western North Atlantic warnings and coded analysis
1900 to 1945	NWS	Western North Atlantic warnings and forecasts
2300 to 0000	FWC	Norfolk/Rota NORLANT/EASTLANT/MED weather

Radio station	Frequency (kHz)	Remarks
Iceland/NRK	5167	1900-0800
Norfolk/NAM	16180, 8090, 12135 20225	1200-2400 only
Thurso/GXH	3724	1900-0800 only
Rota/AOK	5917.5 7705	
Greece/NGR	4623 13372.5	0800-1900
Key West/NAR	5870 25590	1200-2400 only

Note: All broadcasts are keyed simultaneously out of NORFOLK/NAM.

Mariners experiencing difficulty receiving Atlantic high-seas weather according to this schedule are encouraged to report specific details to the National Weather Service.

The National Bureau of Standards has announced that their Time and Frequency radio stations WWV and WWVH will broadcast on 2.5, 5, 10, and 15 MHz. The frequencies 20 and 25 MHz were discontinued on February 1, 1977.

The weather portion of the broadcast will remain as follows:

Times of broadcast	Broadcast area
WWV	
8 min past the hr 9 min past the hr	Storm information for western North Atlantic, including the Gulf of Mexico and Caribbean Sea.
10 min past the hr 11 min past the hr*	Storm information for North Pacific east of 140°W.
WWVH	
48 min past the hr 49 min past the hr 50 min past the hr 51 min past the hr*	Storm information for North Pacific; also the South Pacific to 25°S, 160°E, to 110°W.

*This segment may be broadcast when there are unusually widespread storm conditions.

The Atmospheric Environment Service of Canada has announced the commencement of operations of a continuous VHF-FM Weatheradio station. Vancouver-Victoria Station CFA-240 went on the air on a frequency of 162.40 MHz in January 1977. Although Weatheradio for the Vancouver-Victoria area is the first of its kind in Canada, additional stations are planned for other cities over the next few years.

ACKNOWLEDGMENTS

Thanks to N.T. Nielsen, LLOYD BAKKE; W. van Zoelen, ALKMAAR; and John E. Oberlin, SS HESS VOYAGER, for recent information relative to the marine weather program.

Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

CYCLONE TESTS ATWOOD'S SHENANDOAH

The following is taken from an article by Russ Leavens of Atwood Oceanics, Inc. The article appeared in the November 1976 issue of Ocean Industry and is reprinted with their permission. Time is local standard time.

The SHENANDOAH (fig. 39), a jack-up drilling rig owned by Atwood Oceanics, Inc., of Houston, Tex., and her crew added another "first" to a growing list of accomplishments.

On June 2 and 3, 1976, the men aboard the SHENANDOAH rode out a cyclone in the Arabian Sea off the west coast of India. The rig was jacked up and drilling in 238 ft of water at Platform "A," which is owned by the government of India. Driving rain pushed by winds of over 100 mi/h were encountered during the storm, yet drilling operations never stopped.

Rig manager, James Weeks, wrote: "We had no choice but to continue. The cyclone made up in the key-slot of the SHENANDOAH." Indeed, the storm gave very little advance notice, but left her calling card of damages scattered over the sea and beaches.

At 0700 on June 2, the wind was 2 to 3 mi/h, swells were 1 ft, waves 1 ft, and visibility was fair to good. By noon, the wind was picking up rapidly; it now was blowing 45 to 50 mi/h, with swells 12 to 14 ft and waves running up to 6 ft.

The storm continued to build in intensity as the eye approached the SHENANDOAH. As 2400 drew near, the fully grown cyclone raked the SHENANDOAH with

Figure 39.--The SHENANDOAH pumped India's first offshore oil and was the first jack-up drilling rig out of Brownsville, Tex.

105 mi/h winds, swells of 22 ft crest to trough, pushing up to 9-ft seas. Waves of 31 ft (maximum height) beat at the steel legs of the SHENANDOAH. The storm moved past by 0100 on June 3.

The SHENANDOAH stood safe as the cyclone continued to grind toward the Indian coast. Its might stopped operations on every other drilling unit in the area and caused several to sustain extensive damage. Fishing boats and villages were ravaged as the mighty storm passed into the Indian mainland.

The storm put the SHENANDOAH and her crew to a rigorous test. They maintained a calm, business-as-usual attitude throughout the grueling ordeal.

At 2200 on June 1, the preliminary cyclone report was received. It was not known in which direction the cyclone was traveling. Without knowing the heading of the storm, a decision to abandon could not be made. After discussing the situation, the toolpusher and barge engineer decided to secure the unit for a storm. As securing proceeded, drilling operations continued and a weather watch was started. The wind, rain, and surging sea made the normally hectic daily schedule even more challenging. Drilling ahead continued until 2230, when torrential rains cut visibility and made operating the directional surveyor's recording gear impossible. Only then did the crew stop making hole.

Cyclone data logged by SHENANDOAH

Location:	Arabian Sea - Bombay High area/Oil Natural Gas Commission Production Platform "A"
Coordinates:	Latitude: 19° -32' -8" North Longitude: 71° -18' -49" East
Water depth:	238 ft
Maximum wind:	105 mi/h (recorded)
Maximum swell:	22 ft--7 to 9 second period*
Maximum sea:	7 to 9 ft--2 to 3 second period*

*Observed

At this time, they started working the pipe and circulating the hole. Drilling ahead was resumed at 0100 on June 3, after the squalls of rain slackened.

Tropical storms always create difficulties in radio communications. The radio watch of the SHENANDOAH kept the rig's radios operating during the buffeting. Jacked up above the crest of the waves, the SHENANDOAH could receive weak signals from other rigs and vessels. As the cyclone moved toward land, the rig acted as a communication hub, relaying messages from vessel to vessel and keeping a continuous flow of weather information transmitting to the Oil and Natural Gas Commission radio in Bombay. This valuable service may have helped avert an even greater toll of damage to marine equipment in the area.

Three tropical cyclones roamed the Southern Hemisphere during November and December (fig. 40). Brigitta made her appearance in November, while Ted and Harry made their debut in December. Usually, four to five tropical cyclones develop between the two ocean basins during this period.

SOUTH INDIAN OCEAN
NOVEMBER AND DECEMBER

Brigitta was born just west of Diego Garcia on November 15. For the first 11 days of her life, as a depression, she meandered southward. She even turned a clockwise loop before settling on a westward course. On the 26th Brigitta became a tropical storm. She reached her peak on the 29th and early on the 30th when winds were estimated at about 40 kn as she passed the Malagasy Republic. On December 1, Brigitta moved through the Archipel Des Comores, weakened, and turned southward along the Mozambique coast.

December 15 marked the debut of Harry. He formed just east of 100°E near the Sunda Strait, but he quickly moved westward into the Indian Ocean waters and, thus, will be considered as a South Indian tropical cyclone. Harry was a tropical storm by the 17th (fig. 41). He developed maximum winds of about 60 kn as he passed just north of the Cocos-Keeling Islands on the 19th. However, Harry began to weaken within the next few days.

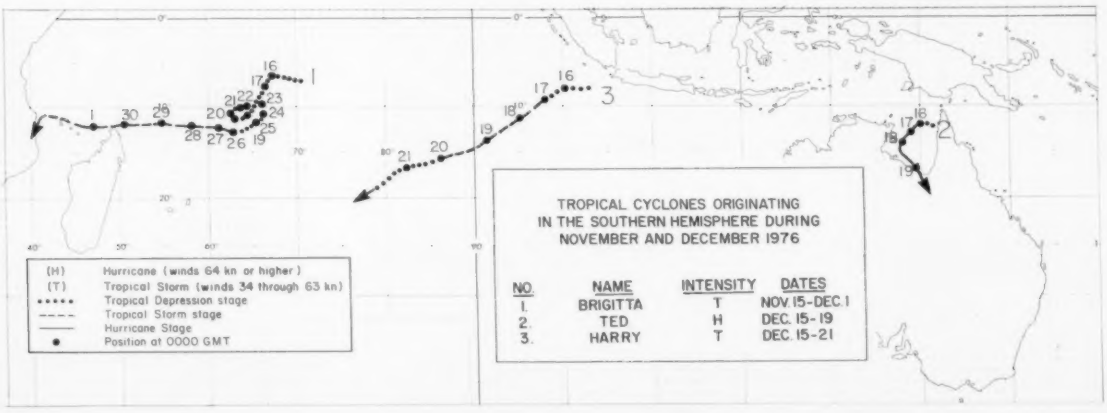
TROPICAL CYCLONES ORIGINATING
IN THE SOUTHERN HEMISPHERE DURING
NOVEMBER AND DECEMBER 1976
NO. NAME INTENSITY DATES
1. BRIGITTA T NOV 15-DEC 1
2. TED H DEC. 15-19
3. HARRY T DEC. 15-21
(H) Hurricane (winds 64 kn or higher)
(T) Tropical Storm (winds 34 through 63 kn)
Tropical Depression stage
Tropical Storm stage
Hurricane Stage
Position at 0000 GMT

Figure 40.--Tracks of Southern Hemisphere tropical cyclones, November and December, 1976.

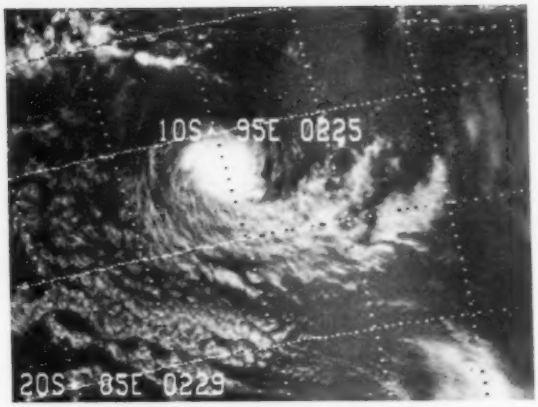

Figure 41.--Harry, a compact, intensifying storm, nears Cocos Island on the 18th.

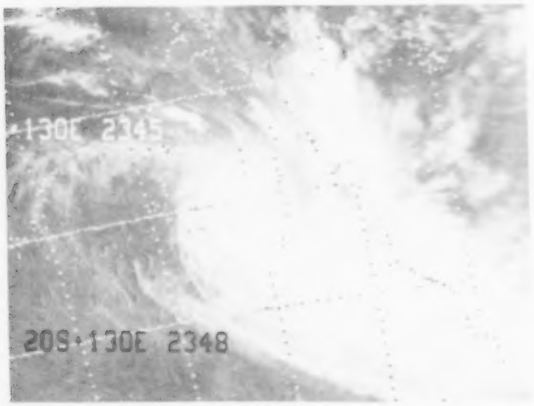

Figure 42.--Ted's circulation covers the Gulf of Carpentaria, the York Peninsula, and northern Queensland on the 19th.

AUSTRALIA-SOUTH PACIFIC REGION
NOVEMBER AND DECEMBER

Ted was a December storm that formed in the Gulf of Carpentaria. He was the only tropical cyclone that reached tropical storm strength in these waters. Ted was a tiger. He was first spotted on the 15th off Cape York and by the 17th winds whipped up to 85 kn. The following day they were near 100 kn. Ted moved west-southwestward toward Arnhem Land, then turned south-southeastward and made landfall over Queensland (fig. 42).

Word has reached us that two December storms, Kim and Laurie, hit the Samoa Islands; details in next issue.

NORTH INDIAN OCEAN
NOVEMBER AND DECEMBER

The Bay of Bengal was the scene of all the tropical activity during these two months. Two cyclones developed in November, while one came to life in December (fig. 43). The average is 1.1 tropical cyclones in November and .5 in December.

The first of the November storms was spotted over the Andaman Islands on November 1. This is a common spawning ground, and climatology also indicates that a westward-to-northward movement is likely. The storm headed west-northwestward, attaining tropical storm strength by the 3d. A peak intensity of about 50 kn occurred just before landfall south of Masulipatam on the Coromandel coast (fig. 44).

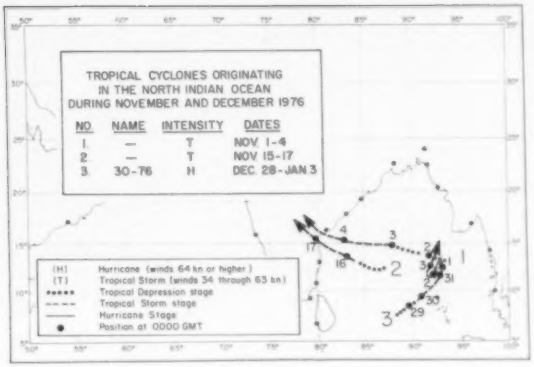
TROPICAL CYCLONES ORIGINATING
IN THE NORTH INDIAN OCEAN
DURING NOVEMBER AND DECEMBER 1976
NO. NAME INTENSITY DATES
1. — T NOV 1-4
2. — T NOV 15-17
3. 30-76 H DEC. 28-JAN 3
(H) Hurricane (winds 64 kn or higher)
(T) Tropical Storm (winds 34 through 63 kn)
Tropical Depression stage
Tropical Storm stage
Hurricane Stage
Position at 0000 GMT

Figure 43.--Tracks of North Indian Ocean tropical cyclones, November and December, 1976.

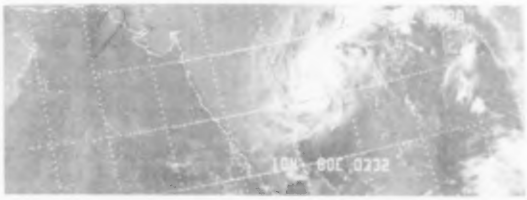

Figure 44.--Early November cyclone nears landfall as it reaches peak intensity.

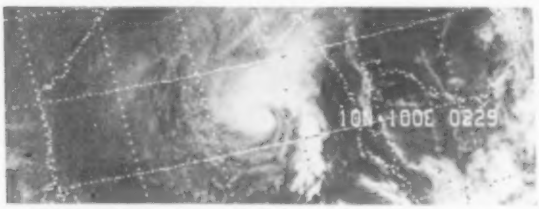

Figure 45.--North Indian cyclone is at peak intensity on the last day of the year.

On the 15th, another storm came to life about 300 mi west of the Andaman Islands. Its movement was also toward the west-northwest. Maximum winds in this cyclone were estimated at 60 kn on the 16th. Before the day was over, the cyclone came ashore about 60 mi south of where the previous storm had made landfall.

Toward the end of the year, a cyclone developed some 300 mi west of the Nicobar Islands. This is a common region for the development of December cyclones. Its northeastward movement, however, was most unusual. By late on the 30th, the cyclone had reached hurricane intensity just south of Port Blair on South Andaman Island. It turned northward and reached a peak of about 85 kn on the 31st (fig. 45). However, with the coming of the new year, the cyclone began to weaken and meander erratically.

On the Editor's Desk

NOAA TEAM AT SITE OF OIL SPILL

Almost a score of NOAA personnel were on temporary duty at Cape Cod, Mass., site of the East Coast's largest oil spill, collecting data on how 7-1/2 million gallons of industrial oil from the wrecked ARGO MERCHANT (fig. 46) was behaving and how it affected land and waters of the area.

The first members of the NOAA Spilled Oil Research Team arrived at Hyannis, Mass., on the day of the spill--December 15, 1976--and were joined by others, working through the Christmas and New Year holidays.

Additionally, the DELAWARE II, an NMFS research vessel, worked the spill area, taking samples of fish life, while the National Weather Service provided special forecasts for the area.

The Spilled Oil Research Team was created to collect oil spill information with the goal of improving predictive modeling techniques to a point of high utility and accuracy.

Major areas of interest to the team include determining more accurately the speed with which oil moves over surface water and how quickly it breaks up and enters the water column.

Thus far at the ARGO MERCHANT spill, the team has gathered evidence that indicates the spilled oil is not sinking in large concentrations and that the level of bottom contaminants from the spill may be small and spread over a large area.

Over the New Year's weekend a 7-ft NOAA data buoy was deployed in the center of the largest "pancake"--a 300- by 700-ft glob of oil 6 in thick. It was tracked by NIMBUS satellite twice daily, giving accurate measurements of the oil movement. Earlier, surface currents and the absolute velocity of the oil had been measured by "tagging" oil patches with drift

Figure 46.--The broken halves of the Liberian tanker ARGO MERCHANT swirl in a sea of foam whipped by high winds after the tanker split on December 21, 1976. The vessel, with a cargo of heavy industrial fuel oil, was bound for Salem, Mass., when she ran aground 28 mi southeast of Nantucket Island on December 15. U.S. Coast Guard Photo.

cards. One 90-ft patch was found to have traveled only 47 mi to the southeast in 7 days.

About 6,000 drift cards also were released between the oil spill and Nantucket Island to serve as an early warning to cleanup crews if the oil started moving inshore.

The ARGO MERCHANT spill represents the biggest cold-water oil spill the team has had the opportunity to study firsthand. Information from this spill is expected to be of major importance in predicting the potential danger to the Gulf of Alaska from stepped-up oil transport there.

OPENING DATE FOR SEAWAY TO BE DELAYED

Citing "present heavy ice and extreme winter weather conditions" in the St. Lawrence River and the Welland Canal, the U.S. and Canadian agencies responsible for operating the St. Lawrence Seaway have reported that an official opening date for the Seaway will be announced later than usual this year.

The U.S.' St. Lawrence Seaway Development Corporation and Canada's St. Lawrence Seaway Authority in a joint statement indicated that the St. Lawrence River and Welland Canal sections of the Seaway have experienced one of the most severe winters in memory. To establish a "realistic" opening date, they said, further forecasts are required to determine when ice breakup and milder temperatures will occur.

Climatic conditions will continue to be evaluated, they noted, adding that an official opening date will be set as soon as is "reasonably possible."

In the past the two agencies have been able to announce a firm opening date for Seaway navigation by about the middle of February, with the opening usually falling on or about April 1.

NOAA NATIONAL ANALYTICAL FACILITY

NOAA has established a national facility to detect and help define the infinitesimal chemical changes in sea water or sediments that can signal pollution.

The new facility was established with funds from the Environmental Protection Agency and is located in Seattle, Wash., at the Northwest and Alaska Fisheries Center of NOAA's National Marine Fisheries Service. The facility will serve as a much needed national center for testing marine samples for research projects throughout the United States.

The analytical center's fulltime staff of five chemists will analyze water, sediment, and biological samples for several Commerce Department environmental research programs, testing the samples for traces of petroleum hydrocarbons, chlorinated hydrocarbons, industrial organics and heavy metals. Ultra-sensitive instruments can detect contaminants in water at levels of one part per billion or less. The results of such delicate analyses will be used in a host of energy resource and environmental studies, including efforts to assess the effects of oil and other contaminants in Puget Sound and on Arctic marine life forms.

Sample material collected during the assessment of the impact of the grounding of the ARGO MERCHANT on Nantucket Shoals in December 1976 will be tested at the facility.

The analytical facility staff will provide advice on how to collect samples without contaminating them. The human hand, for example, carries hydrocarbons, and the touch of a finger on a biological sample can completely distort results. The Seattle center will help various environmental programs standardize their collection and analysis methods so the results will be consistent.

Among the facility's main customers will be the Outer Continental Shelf Environmental Assessment Program, which is conducting a major study of the effects of oil leasing in the Gulf of Alaska for the Interior Department's Bureau of Land Management, and the Marine Ecosystems Analysis Program Office, a project involved in such problems as deep sea mining in the Pacific and the impact of the New York and Seattle metropolitan areas on adjacent waters. Both programs are part of NOAA's Environmental Research Laboratories.

A third main customer is the group from the National Marine Fisheries Service which deals with environmental research and habitat protection. The facility eventually will work with other government agencies, universities, and others conducting marine environmental research.

ADDRESS CHANGE FOR HOUSTON PMO

The address for the Port Meteorological Office in Houston, Tex., has changed from the one listed on the back cover of the January 1977 issue of Mariners Weather Log. The current address and telephone number (which remains the same) is:

Mr. Julius Soileau
Port Meteorological Officer
National Weather Service, NOAA
Route 5, Box 1048
Alvin, TX 77511

NOAA SCIENTISTS MEASURE WIND'S EFFECT ON CURRENTS IN NORTHERN PUGET SOUND

If an oil tanker has an accident in northern Puget Sound, NOAA scientists hope it will not be on a windy day.

A study of winds and currents in the southern Strait of Georgia near Cherry Point, the site of an oil refinery, has shown oceanographers that wind is the dominant force moving the waters and anything spilled on them.

Scientists with NOAA's Pacific Marine Environmental Laboratory in Seattle are studying the relative importance of different factors--wind, tide, river flow--affecting water movement in that northwestern channel. They reported at the fall annual meeting of the American Geophysical Union in San Francisco that their research has a dual purpose--to understand the currents and to collect some preliminary data on the area to help design their part of a bigger study.

NOAA's Marine Ecosystems Analysis program office, with funding from the Environmental Protection Agency, is conducting a major study aimed at assessing the ecological impact of increasing shipment and refinement of oil in northern Puget Sound. Physical oceanographic research by scientists from the NOAA Seattle laboratory will be closely coordinated with this project. An early goal is to determine what might

happen to oil spilled by tankers carrying crude oil through the San Juan Islands to the refinery at Cherry Point. Such traffic is expected to increase in the future, as the Puget Sound region becomes an important terminus for Alaskan oil.

The Seattle laboratory used their own measurements and current meter data collected by NOAA's National Ocean Survey. The Survey had collected the data as part of a continuing effort to update its tide prediction tables.

They hope to determine how water responds to variations in local forcing, such as winds, and develop a local model that can be used to tell what the currents in the area will do if the wind is blowing so hard in a certain direction.

To the Survey's current meter data, measurements with drogues were added. These devices consist of large vanes connected to a surface float to mark its position and travel with the currents.

The researchers tracked the drogues by radar to determine successive positions of each relative to shore. After a day or so, when a drogue had drifted out of the area of interest, it would be picked up and deployed somewhere else.

The Seattle group also used wind measurements from Sands Head, Saturna Light, and Cherry Point. They found that winds blow generally along the northwest-southeast axis of the Strait of Georgia. Currents in the southern part of the Strait are dominated by tides, which account for 70 to 80 percent of the total variability in water movement.

One portion of flow that cannot be attributed to tide, they found, is estuarine flow. Fresh water from the Fraser River flows out into the Strait in the upper part of the water column, dragging along some of the saltier water beneath it. This leads to an inward flow to replace the surface water. Winds modulate this estuarine regime.

Cherry Point, however, is out of the path of the estuarine flow, and tidal currents are weaker. Here, winds are the major influence on currents. On some occasions, sustained winds of over 20 kn caused currents of up to 1/2 kn.

NOAA, UNIVERSITY SCIENTISTS USE SATELLITES TO STUDY MAGNETIC STORM WAVES

Simultaneous observations by three satellites have confirmed that long waves in the Earth's magnetic field, which spread the disruptive effects of magnetic storms on Earth, are generated far out in space by energetic particles from the Sun.

The scientists from NOAA's Space Environment Laboratory, the University of California, and London's Imperial College found that low-frequency waves are generated by the solar wind, the constant stream of energetic particles that flows outward from the Sun. When the solar wind strikes the magnetopause (the boundary where the Earth's magnetic field loses its dominance and bows to the Sun's), it generates waves in much the same way as wind does over water. These waves travel earthward, enter a "resonant region" where they are amplified, and propagate down to the ground. In ways that are still poorly understood, they are involved in magnetic disturbances, which disrupt communication and power transmission on Earth.

They also have some pragmatic uses in oil and mineral exploration. By monitoring the waves as they travel through different spots on Earth, prospectors can learn something about the substructure, such as the location of ore bodies. Paradoxically, the waves may also aid communication. Since they penetrate the ocean, they may someday be used to communicate with submarines, which now have to surface to make contact.

The waves were detected from magnetometers aboard three satellites in synchronous orbit 22,200 mi (35,720 km) above the Earth; this was the first time several satellites had been used to make such measurements simultaneously. The environmental satellites SMS-1 and SMS-2 and ATS-6, a research satellite, are in a line along the Earth's equator, each orbiting at a speed that keeps it poised above the same spot on Earth.

The magnetopause curves around the sunward side of the Earth, with a "nose" pointing toward the Sun. The space scientists predicted that if the low-frequency waves were generated at the "nose" as believed, the first satellite to detect the descending wave front should be the one closest to the Sun at the time. They found that the wave front did pass each satellite in the predicted order. The satellite measurements also showed how the waves are amplified and propagated. Originally, it was thought that the lines of force of the Earth's magnetic field would vibrate like a guitar string, setting up the waves.

Early ground-based observations also had suggested that as a wave generated at the magnetopause travels inward toward Earth, its amplitude decreases until it reaches a certain altitude, a "resonance region," where it is amplified. The three satellites are located right at this resonance region. Measurements from the satellites confirmed the existence of the resonance region by observing the change in amplitude of descending waves. The "guitar string" theory was not all wrong, but the waves do not originate at a magnetic field line; they are amplified there. A wave travels earthward until it finds a magnetic field line that responds to the particular frequency of the wave. This is the resonance region.

The scientists used the amplitude changes of the waves to infer some of the characteristics of the resonance region. By noting how changes in amplitude of the waves differ between the satellites, the researchers found that the resonance region is very narrow on a magnetospheric scale--about 750 mi (1,200 km) thick.

The next step in the research is to look at the characteristics of the waves--what are the spatial limits of where they occur and how they relate to local features of magnetic disturbances.

The scientists hope to study the wave frequencies to learn something about how matter is distributed along magnetic field lines. First, it is necessary to calibrate the waves--to learn what different wave characteristics perceived at Earth reveal about what is going on farther out in space. For that, the satellites, with their direct measurements, are needed. Later, it may be possible to use the waves that reach Earth to study the magnetic field thousands of miles above.

LORAN-C STUDY

The U.S. Coast Guard is funding research which will help to minimize the problems associated with the

conversion from Loran-A to the new Loran-C navigational system. The year-long study is being financed by a $91,000 grant from the Coast Guard and will be conducted through Oregon State University.

Information for the study will come from Loran users--merchant mariners, professional fishermen, oceanographers, recreational sailors, and Coast Guard personnel. Recommendations from the project, which is scheduled for completion in the fall of 1977, will attempt to assist Loran-A users in the orderly conversion to the more accurate, longer range Loran-C system.

Loran-C is now available in some Alaskan waters and along much of the East Coast. The construction of new stations will provide nationwide Loran-C service by 1980.

URI OCEANOGRAPHERS GET NEW RESEARCH SHIP

University of Rhode Island oceanographers now have a 177-ft, steel hull research vessel for use in their coastal and oceanic studies.

The new, $4 million deep-sea research vessel ENDEAVOR arrived at the URI Narragansett Bay campus in mid-November 1976, completing her maiden voyage from the Peterson Builders, Inc., shipyard in Sturgeon Bay, Wis., where she was constructed.

The vessel measures 165 ft at her waterline and has a 34-ft beam and a 17-1/2 ft draft. Her displacement is 972 tons, gross tonnage 291 tons, and net tonnage 217 tons.

ENDEAVOR (fig. 47) is capable of spending up to 30 days at sea and traveling 10,000 mi between ports. Her maximum speed is 15.4 kn with a minimum speed of 1/10 kn. She will be operated by a crew of 12 and can carry up to 16 scientists who will be able to conduct all phases of oceanographic research in both coastal and oceanic regions.

ENDEAVOR was built to replace URI's first research vessel TRIDENT, which was retired in December 1975 after 14 yr of ocean research in which she logged nearly 500,000 mi and averaged nearly 250 days a year at sea.

The new ship's construction was financed by a contract from the National Science Foundation, which retains ownership of the vessel. The URI oceanography school will operate the ship under renewable, 5-yr no-cost charter agreements with NSF. Operating expenses for ENDEAVOR will come from Federal grants.

The URI vessel is the third in a series of ocean research ships recently financed by NSF in an effort to update the nation's academic research fleet. Although all three were constructed by the Wisconsin shipbuilders, ENDEAVOR's design was modified to allow more laboratory space than its two sister ships, OCEANUS at Woods Hole Oceanographic Institution and WECOMA at Oregon State University.

ENDEAVOR is powered by a 2,800 hp turbo-charged diesel. This engine drives a controllable pitch propeller. A trainable water jet bowthruster with 320 hp

Figure 47.--The University of Rhode Island's new research ship ENDEAVOR.

direct current variable speed drive is fitted for low speed and take-home power. The vessel has three 440-volt generators.

On deck, the vessel has hydrographic winches, a deep sea winch, and an anchor windlass, all with hydraulic drive. The vessel has steering control stations in the pilot house, port and starboard bridge wings, and the winch control house. Navigational equipment includes radars, gyroscope, Loran-A and C units, and satellite navigation equipment. Communications needs are handled by VHF/FM&SSB radios.

ENDEAVOR has almost 1,000 ft^2 of space for its three laboratories, which are easily accessible to the working deck area. This working deck, approximately 1,300 ft^2, is located aft and close to the waterline, making the operation of scientific equipment much easier. The cargo hold is about 420 ft^2.

Quarters are located amidship below the break deck. There are seven double scientific staterooms with adjoining baths and seven double staterooms for the crew. The master's quarters are aft of the chart room. Because the ship will work in tropical areas, both the quarters and the labs are air conditioned.

The new ship was named after the sailing ship on which Captain James Cook made a scientific circumnavigation of the globe in the 18th century.

PUBLICATIONS OF INTEREST TO MARINERS

ANGLERS' GUIDE TO ATLANTIC COAST

A study of the location of marine recreational fishing grounds, the various fishing and boating facilities available, local conditions and characteristics of fishing, life habits, and environmental requirements of recreational fishes along the Atlantic coast has just been published by NOAA.

Entitled "Anglers' Guide to the United States Atlantic Coast" and issued in four sections, the publication covers saltwater fishing from Virginia to Florida. It is authored by Bruce L. Freeman and Lionel A. Walford of the National Marine Fisheries Service laboratory at Sandy Hook, N.J.

These sections are the second half of an eight-section study which embodies the entire coast from Maine to Florida. Section V ($1.60) covers the Chesapeake Bay; Section VI ($1.70), False Cape, Va., to Altamaha Sound, Ga.; Section VII ($1.70), Altamaha Sound, Ga., to Fort Pierce Inlet, Fla.; Section VIII ($1.80), St. Lucie Inlet, Fla., to the Dry Tortugas. The first four sections were published in 1974.

The published sections include subarea maps of the tidal shoreline, indicating wetlands as well as city, county, and Federal parks and wildlife areas. Principal roads and towns, marinas, ramps, docks, and other fishing facilities are shown, as are fishing grounds, locations of wrecks, artificial reefs, and areas to the edge of the Continental Shelf where the most popular fish are commonly caught. Illustrations of the fish available, along with brief descriptions of their habits, distributions, and seasons of abundance, are included. A text accompanying each section discusses topography, climate, tides, history of fishing, conservation problems, and some biology of the more frequently caught fish. Each section also contains a glossary of fisheries terms.

The first four sections cover the area from Maine to Virginia: Section I, Passamaquoddy, Maine, to Cape Cod ($1.60); Section II, Nantucket Shoals to Long Island Sound ($1.60); Section III, Block Island to Cape May, N.J. ($1.70); Section IV, Delaware Bay to False Cape, Va. ($1.60).

The sections can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

ADDENDUM

The following paragraph, which gives credit for work described in the article, "Plate Tectonics Provides Clues to Location of Mineral Resources" (Editor's Desk, page 21, January 1977 issue), was inadvertently left out.

Geophysical scientists P.A. Rona of the National Oceanic and Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratories (AOML) and L.D. Neuman of the United Nations Centre for Natural Resources, Energy and Transport (CNRET) have made a study of the energy and mineral resources of the Pacific region in the light of plate tectonics. Working in AOML's Marine Geology and Geophysics Laboratory in Miami, Fla., and at United Nations Headquarters in New York, they have explained and illustrated the presence of a variety of minerals important to our industrial economy and have designed and constructed geological models which, while now indicating the distribution of known deposits, may be used on further refinement to locate more accessible deposits in other areas of the Earth's crust.

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 52-55], climatological data from U.S. Ocean Station and Buoys [tables 8 and 9], and gale and wave tables 10 and 11), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

September and October 1976

SMOOTH LOG, SEPTEMBER 1976--Extratropical storm activity along the northern great circle routes was less frequent than normal. This was reflected by large anomalies of plus 13 mb at the surface and plus 118 m at 700 mb. These anomalies were centered over Iceland with lesser values covering much of the eastern North Atlantic. Only a few storms traversed these normally active waters. Extratropical storms were plentiful around the Gulf of St. Lawrence and off the coast of Newfoundland. This resulted in anomaly centers of minus 3 mb at the surface and minus 36 m at 700 mb along the St. Lawrence River.

South of about 45°N, the Bermuda High prevailed at the surface and aloft, except for three tropical and one extratropical intrusions. Hurricanes Emmy and Frances along with an intense LOW were the primary reasons for an area of negative anomalies (maximum minus 3 mb at the surface and minus 40 m at 700 mb) stretching from the Azores to Europe. Tropical cyclone activity was a little below normal with one hurricane, Gloria, developing toward the end of the month. A description of hurricane Gloria can be found in the article "North Atlantic Tropical Cyclones, 1976" appearing on page 63 of this issue.

Extratropical Cyclones--The month opened with the intensification to 965 mb of a Norwegian Sea cyclone. The LOW was spawned northeast of Iceland at the end of August. On September 1, 40- to 45-kn gales raked the seas between Jan Mayen and the coast of Norway. The storm weakened as it moved across the North Cape the following day. However, a strong flow continued over the Greenland, Norwegian, and North Seas for several more days.

On the 7th, a wave formed just south of Iceland along a stationary front which stretched from Labrador to Scotland. By the 9th, it was an intensifying, 985-mb LOW roaming the North Sea. The DE HOOP sailed into 44-kn northerlies among the Hebrides at 0000. Conditions were no better in the North Sea where ships and rigs were beseiged by gales and high seas. Between 54° and 60°N the WHITETHORN, ELIZABETH BOWATER, ROMI, and ODEN DRILL all reported 40- to 45-kn winds. At the northern entrance to the North Sea the ROMI and ODEN DRILL also encountered 20- to 30-ft seas. Conditions worsened on the following day as the LOW swung northward to the coast of Norway and generated a strong westerly to northwesterly flow across the North Sea. Winds of 45 to 50 kn were common. At 0600 the ROMI was still under siege, battling 50-kn northerlies in 25-ft seas near 60°N, 2°E. As the storm attempted to traverse the rugged terrain of Norway and Sweden, another formed near 60°N, 25°W, and moved southeastward. The dying Norwegian LOW had one last gasp and caused the 64-kn winds that whipped the EXPLORA at 1200 on the 11th near 70.8°N, 8.5°E.

Meanwhile, the new LOW had centered itself over the Irish Sea by 0000 on the 11th. Gales were reported all around the 990-mb center. To the southwest, a cold front passage was responsible for 60-kn winds which blocked the English Channel entrance for the TRENTWOOD. Winds of 45 to 50 kn were common, and the GREAT RIVER ran into 25-ft seas off the west coast of Ireland. Along that coast the BELMULLET reported 45-kn winds. The following day the 990-mb storm moved slowly northeastward and began to weaken.

Another storm was brewing in the Denmark Strait on the 12th, however, and soon arrived to take its place among this month's North Sea storms. By 1200 on the 14th, the LOW was centered over southern Norway with a wave along its front over England. The people of the United Kingdom welcomed the storm as they were having the worst drought in 500 yr. In the northeastern sections, 4 in of rain fell in 24 hr with winds to 78 kn--the worst storm in 25 yr. The drought was by no way broken as the heavy rain ran off and did not spread evenly. Water rationing remained in effect, and new restrictions were applied in some areas.

Reports of 40- to 50-kn winds and 10- to 15-ft seas were flocking in from ships northwest and west of the main center. The ROMI, victim of a previous storm, was plagued by 52-kn winds in 25-ft seas near 60°N, 2°E. By 1800 the ROMI moved closer to the coast of Norway, and conditions abated somewhat as winds dropped to 40 kn and seas to 15 ft. The LOW stalled as 40- to 45-kn winds and 10- to 20-ft seas plagued

the North Sea, north of 55°N, through the 15th.

That same day a LOW was deepening rapidly south of Greenland. This storm was spawned from a system that had developed over the Great Lakes on the 10th. It had moved northeastward into Quebec and weakened. The remaining frontal system triggered the development of a new LOW just south of Newfoundland on the 13th. By the 15th gales were raging around its 990-mb center. To the south the C7C encountered 42-kn winds in 18-ft seas at 1800. Nearby, the QUEENSGARTH reported 48-kn gales. Early on the 16th, there were several gale reports to the south of the 982-mb center, but by 1200 another system had entered the spotlight.

This new storm had similar origins. It began as a frontal wave along the St. Lawrence River on the 14th. Moving eastward, it intensified off the coast of Newfoundland. By 1200 on the 16th, its center was near 50°N, 42°W, causing gales to the east, west, and south. At 1800 the AMERICAN ACCORD found 41-kn winds and 18-ft seas with 10-ft swells at 48.5°N, 42.6°W. The C7C, battered by the previous storm, was ripped by 54-kn northwesterlies in 15-ft seas, 100 mi southwest of the storm's center at 0000 on the 17th. The QUEENSGARTH and several other ships encountered 45- to 50-kn winds in 20- to 25-ft seas about 300 mi southeast of the center. The next day a 986-mb center indicated a weakening of the storm.

Early on the 19th, the remnants of the two previous storms combined with a frontal wave in the mid-Atlantic to produce a large, complex, multicentered system. Within a few hours this system got it together into a large LOW with a 981-mb center near 57°N, 30°W. Its circulation ranged from the Denmark Strait to the Bay of Biscay. Strong winds were observed in the western semicircle, where they averaged 40 to 45 kn. The THUREDRECHT, 180 mi to the south, sailed through 45-kn winds and 15-ft seas. As the 980-mb LOW traveled toward the east-northeast, a front preceding it swept the English shores with strong winds. Testifying to this was the LEOPARD, which clocked 40-kn winds in the English Channel, and the LE FRINGANT, which battled a 60-kn blow in St. Georges Channel, on the 21st. The next day the LOW turned slowly southeastward and began to fill. Meanwhile, another LOW had formed along the southwest extension of the front. This system was to move east-northeastward, envelop its weakening sister, and become the blockbuster of the month.

Unstable conditions associated with the passage of several small LOWs occurred on the Great Lakes from the 21st to the 23d. The J. L. MAUTHE encountered 46-kn winds and 11.5-ft waves on Lake Superior on the 21st; the JOHN SHERWIN fought 42-kn winds and 10-ft seas on northern Lake Michigan on the 22d. On the 23d the JOHN DYKSTRA hit 46-kn winds and 10-ft seas on Lake Huron, while the CHARLES M. BEEGHLY reported 46 kn and 13 ft on Lake Superior.

Monster of the Month--By 0000 on the 23d, the 996-mb center was pinpointed at 47°N, 15°W. The FNXE was battling 64-kn northwesterlies 360 mi to the west. Twelve hours later, the roof fell in as five ships reported winds ranging from 50 to 60 kn. Seas were running 10 to 20 ft. The HUGO OLDENDORFF fought 60- to 65-kn winds in heavy seas for at least 6 hr. The CRANIA and the TEMPLE INN spent the day in 50-kn winds and seas running up to 25 ft. Most of the action was south through west of the center and remained that way through the 25th. Into the middle of this mess sailed the Norwegian tall ship CHRISTIAN RADICH returning from its bicentennial tour of the eastern United States. Its sails were shredded by hurricane-force winds, and the Coast Guard reported that it drifted helplessly for a time. A Norwegian tanker stood by, but the training ship, with a crew of 113, was able to limp into Falmouth harbor under its own limited power. Meanwhile, the storm had become stationary near 47°N, 15°W. On the 25th it began to fill, although you could not prove it by the NOVA GORICA who called in 50-kn winds 200 mi to the southwest. The AMERICAN LEGEND was weary, having battled 40-kn winds and 17-ft seas with 18-ft swells for 3 days. The GREEN HARBOUR experienced the same winds and seas on the 24th and 25th but swells reached 33 ft. By the 26th the central pressure had risen to 989 mb, and the LOW began to drift northeastward. It was still on the maps as a weak stationary LOW off Mizen Head as the month came to a close. The 9,733-ton Liberian bulkcarrier APILIOTIS put into Balboa on the 28th to pump water out of the holds which flooded in heavy weather on route from Ponta Delgada, Azores.

The last storm of the month developed from a frontal wave that had moved across New England. On the 28th the budding circulation unveiled over the Gulf of St. Lawrence with a cold front trailing southwestward into the United States. The NOVA GORICA, battle-scarred by the previous storm, encountered 50-kn southerlies some 250 mi southeast of the storm's center. The AMERICAN LEGEND, another veteran of the previous storm, bucked 42-kn winds and 15-ft swells. The system intensified rapidly and continued on a northeasterly heading. By the 29th the central pressure had plummetted below 972 mb. Winds of 40 to 45 kn and seas to 21 ft were reported to the south by the SEA-LAND RESOURCE, AMERICAN ALLIANCE, and PRIVATE JOHN R. TOWLE. On the 30th the system was centered off Kap Farvel. Its sphere of influence extended into the Davis and Denmark Straits and south to about 50°N. At month-end the storm's center split in two--one off each coast of Greenland. This division resulted in a rapid

weakening of the system.

Casualties--At this time, no reports of casualties other than those mentioned in the text have been received.

SMOOTH LOG, OCTOBER 1976--The majority of the significant cyclones occurred during the second half of the month. There were two primary cyclone tracks that affected shipping. One was from the Gulf of St. Lawrence to south of Iceland; the second was from off the east coast of the United States to northern Europe. These closely approximated the climatological tracks. There were secondary tracks over the Labrador Sea and off the west coast of Europe.

The mean monthly pressure centers were near their climatological counterparts, but the central pressures were more intense than the climatic mean. The Icelandic Low was 992 mb versus the climatic mean of 1001 mb near 61°N, 30°W. The Azores High at 1024 mb versus 1019 mb according to long-term climatology, was near 32°N, 34°W. There were isolated high-pressure centers over the eastern United States. A 1026-mb High was centered north of the Black Sea with a pronounced trough oriented northwest-southeast across France into the Mediterranean.

There were two large departure-from-normal centers. The most significant for the majority of ships was the minus 12-mb center over Lands End. This was a reflection of the trough mentioned earlier. A large 14-mb positive anomaly center was near Nordkapp, Norway. This was associated with a ridge from the High north of the Black Sea. The higher pressure of the Azores High resulted in a positive 5-mb center near 31°N, 32°W. The triangle of ocean bounded by the east coast of North America, north to Newfoundland, and south along 50°W, was within 1 mb of the long-term mean.

The upper air at 700 mb was mainly zonal over the major shipping lanes. A Low was centered east of Kap Farvel with a moderate trough along the Appalachian Mountains and a sharp trough from the LOW across Ireland and France.

Hurricane Holly formed during the last week of the month. A description of this storm appears in the article "North Atlantic Tropical Cyclones, 1976" on page 63.

Extratropical Cyclones--The first storms of the month were not as intense as those which came later. The circulations did not develop as large as they broke up into multiple centers.

This storm originated as a frontal wave south of Newfoundland on the 3d and traveled around the outskirts of a LOW centered near Iceland. It was not until after 0000 on the 5th that the isobars on the weather chart indicated a closed circulation. At that time the ILLYRIC, near 44°N, 16°W, reported 20-ft swells. At 1200 the TILLIE LYKES was 850 mi southwest of the 972-mb center with 23-ft swells. The COMET near Bishop Rock was fighting 50-kn winds and 14.5-ft swells from the south-southwest. The Ocean Weather Station C7R was tossed by 26-ft waves. At 0000 on the 6th, the ODIN DRILL, at 58.7°N, 01.2°E, in the North Sea, recorded 52-kn winds. At 0600 the ANCHISES was west of the Irish coast and had 44-kn winds and 26-ft swells. At 1200 the LOW was 960 mb near 59°N, 13°W. Many ships throughout the area south and east of Iceland were reporting high winds and seas. The CAPE NELSON fought to stay afloat at 55.6°N, 7.8°W, in 52-kn winds, 23-ft seas, and 49-ft swells.

In the meantime, two peripheral LOWs had formed south and west of the center. As they rotated eastward, the pressure gradient tightened south of their centers with resulting high winds and waves. At 0000 on the 7th, the HANNOVER, far west near 51°N, 43°W, contended with 36-ft swells, while at the same time the ATLANTIC CARRIER was battling 47-kn winds near 48.9°N, 10.4°W.

By the 8th the storm was moving over the Greenland Sea to dissipate over the cold water.

A LOW was moving northeastward over the Labrador Sea late on the 7th. The point of occlusion of the associated front passed slightly south of Kap Farvel, and the 0000 chart of the 8th showed a closed circulation around that point east of the cape. The center moved northeastward into the Denmark Strait. At 0000 on the 9th, the weather station on the Ice Cap, near 65°N, 43°W, reported roaring, 60-kn winds and heavy fog.

At 1200 the METEOR (53°N, 37°W) was tossed by 25-ft seas, and the MINDEN (63°N, 23°W) reported hurricane-force, 78-kn winds. At 0000 on the 10th, the LOW was still in the same area (near 62°N, 30°W) at 971 mb pressure. At 0600 three ships south of the center reported seas or swells between 23 and 28 ft.

By the 11th the LOW was filling as other LOWs approached from the west and southwest. The AMERICAN LEGACY and SEA-LAND ECONOMY fought 50-kn winds about 300 mi southwest of Lands End at 1200 on the 11th in a secondary LOW associated with the system. On the 12th the principal LOW started slowly sliding northward and disappeared.

This storm center remained over land, but its effects were felt by coastal ships as it moved over the Atlantic States. On the 8th a front lay along the Appalachian Mountains, and a wave formed near Plains, Ga. The LOW moved northeastward along the eastern slope of the mountains. Heavy rains and severe weather accompanied the storm. Five tornadoes were reported in North Carolina and Virginia. Gale warnings were posted for much of the East Coast. Thunderstorm winds gusted to 74 kn at Elizabeth City, N.C.; 70 kn near Dulles Airport in Virginia; and 51 kn at Cape Hatteras, N.C. Gusts of 45 kn were reported through eastern Maryland and Pennsylvania. A 63-ft wood sailboat JUSTUS sprang a leak and sank off New Jersey. The Coast Guard and the ASTRALITA rescued those aboard. By 0000 on the 10th, the 982-mb center was over northern Vermont. The strong winds and high waves were well south of the center. The S.A. MORGENSTER, at 38.3°N, 68.3°W, recorded 62-kn winds from the south just ahead of the front. The swells were 25 ft. At 1200 the WILMINGTON GETTY reported 76-kn westerlies behind the front off Cape Cod. Serious flooding occurred with the heavy rains along much of the East Coast from South Carolina northward.

Early on the 11th, the VGBZ measured 50-kn westerlies south of Sable Island. By 1200 the LOW had split into two centers, and the new one east of New-

foundland treated the QUEEN ELIZABETH 2 to 13-ft seas and 20-ft swells. By the 12th both centers had disappeared.

Monster of the Month--This storm formed as a frontal wave in midocean near 49°N, 37°W, at 1800 on the 12th. It quickly deepened, drawing circulation from a LOW near Iceland. At 1800 on the 13th, the SHACKLETON was near 49.1°N, 15.1°W, about 100 mi southwest of the center, with 55-kn winds and 23-ft seas.

At 0000 on the 14th, the 976-mb LOW was near Fastnet Rock. There was little gradient north of the center, but to the south and west there was a strong gradient. South of the center the ARMADALE found 70-kn westerlies. The JOHN MURRAY in St. Georges Channel fought 60-kn winds. Ocean Weather Station Romeo had only 35 kn at observation time with 18-ft seas. The AMERICAN ACE had departed Le Havre and was in the English Channel at about 0200 when she must have passed almost directly through the center of the LOW. Her barograph indicated 964 mb, which was lower than the pressures indicated on either the 0000 or the 0600 charts. At 0600 the STRATHAIRD in the Bay of Biscay logged 50-kn winds from the west with 25-ft swells. At 1200 the ATLANTIC COGNAC (49.9°N, 03.2°W) was bounced by 33-ft waves driven by 50-kn winds. The SUSQUEHANNA was tossed around by 40-kn winds and 14.5-ft seas on top of 42.5-ft swells near 46.8°N, 3°W.

Several ships sank and went aground during this storm. The 7,644-ton East German tanker BOHLEN sank off the Brittany coast. Eleven crewmembers were rescued and 25 were dead or missing. The 1,571-ton Cypriot freighter VLIELAND was being towed by the tug PACIFIC after being abandoned by the crew when it suffered a cargo shift in heavy weather on the 11th. She sank near 47.6°N, 5.5°W, on the 14th. On the 15th, the 999-ton West German vessel ANTJE OLTMANN sank near 51.9°N, 2.7°W, after the cargo shifted in heavy weather. Three of the crew were rescued. Five were dead and one was missing. The 115,135-ton Liberian tanker ANDROS ANTARES went aground in 60-kn winds at Le Havre after breaking her lines. Six tugs freed the vessel at high tide on the 15th. A 10,287-ton Swedish motor vessel went aground near Stockholm. There was no indication that high winds were involved.

By 0000 on the 15th, the chart showed the 976-mb LOW to be over central England. The OLENEGORSK battled 66-kn winds and 33-ft seas at 49.8°N, 5.6°W. At 46.9°N, 3.6°W, the SUSQUEHANNA continued to report high swells (41 ft); the winds had dropped to 35 kn. The LOW was turning northward over the North Sea and weakening, but ships were still reporting winds in the 50-kn and seas in the 20-ft range. Early on the 16th, the closed circulation was absorbed by another LOW.

This low-pressure circulation was first detected on the 16th south of Louisiana over the Gulf of Mexico by reports from two buoys. A cold front moved south off the Gulf Coast and was incorporated into the LOW on the 17th as it moved eastward. On the 18th the LOW raced northeastward off the U.S. East Coast. At 1200 it was 992 mb near 42°N, 64°W, with gale-force winds. At 0000 on the 19th, the DART AMERICA (43°N, 61°W) was plowing into 55-kn winds and 23-ft waves. At 0600 the ANCO STANE was pounded by 50-kn winds and 30-ft swells on her port side. At 1200 the BESSTRASHNIJ, north of Newfoundland at 52°N, 54°W, suffered 66-kn winds and 30-ft seas out of the north. The LOW was 964 mb near 51°N, 51°W. The DLHO reported 60-kn winds and 33-ft seas south of the center at 1800 on the 19th and 0000 on the 20th. The C.P. VOYAGEUR was battered by 36-ft swells near 53°N, 26°W. The 1,200-ton Dutch freighter GABRIELLA sank about 60 mi southwest of Newfoundland. Only 2 of 15 crewmembers survived after abandoning ship. Seven bodies were found on a raft which washed ashore on Newfoundland.

High seas and swells were occurring over a wide area south of the center. At 1200 on the 20th, the VOYAGEUR was at 33°W with 47-kn winds from 280°, and the swell was now 41 ft. The C.V. LIGHTNING (49°N, 29.7°W), 500 mi south of the center, was headed into 55-kn winds and 30-ft swells. At 1800 Ocean Weather Station C7C measured 46-kn winds and 31-ft seas. The ROBERT STOVE reported 46-ft swells at 1800 near 48.7°N, 26°W, and 43-ft swells at 0600 on the 21st. The wind at the latter time was only 30 kn. At 1200 on the 21st, the LOW was 969 mb near 59°N, 25°W. Waves of near 30 ft continued through 1800 on the 22d. The LOW stalled at this position for about 24 hr before taking a southeasterly track. Waves of 20 to 30 ft were relatively common on the chart.

As the storm tracked southeastward, it was filling and weakening, but high swells were still reported. Early on the 24th, it was absorbed by another LOW off Cabo Finisterre.

With the formation of this LOW there were four in a line north to south along approximately 20°W. This one was the third from the north near 51°N, 22°W, at 0000 on the 26th. The center moved northward as the next one to the north disappeared. Gales were starting to blow. Late on the 26th the LOW reached its northernmost point, curved westward, then turned southeastward. At 0000 on the 27th, Ocean Weather Station C7R measured 35-kn winds and 20-ft seas. At 1200 the ANTILLA CAPE (46°N, 19°W) found 50-kn winds and 30-ft seas about 150 mi from the center. Nearby, the SEA-LAND VENTURE was also hitting 50-kn winds, but seas were only 17 ft. The BUNTENTOR fought 50-kn winds and 30-ft seas at 1800. As the LOW moved over Cabo Finisterre, 50-kn winds and waves to 30 ft were still being reported on the 28th. At 1200 the BORDER SHEPHERD,

north of the center at 46.6°N, 7.7°W, had easterly 37-kn winds, 8-ft seas, but crushing 33-ft swells. Early on the 30th, only a weak 1004-mb center could be found near Gibraltar, and that no longer existed by the next chart.

It was only near the end of its career that this storm was significant. It started as a frontal wave on the 28th midway between Bermuda and Cape Hatteras. It raced northeastward with the usual gale and wave reports. On the 1200 chart of the 29th, a new frontal wave developed on the front northeast of this one. It only survived for two synoptic charts, but at 1200 the AMERICAN ALLIANCE (44.7°N, 34.5°W), west of the center, was hit by 64-kn northerly winds with 15-ft seas and swells. The LOW continued northeastward with little change in intensity. By 1200 on the 31st, it was 972 mb near 57°N, 20°W. On November 1, it stalled just south of Iceland and at 1200 was 960 mb. The winds were increasing, and C7L measured 50-kn winds and 23-ft waves. On the 2d the winds were still 50 kn and the waves 25 ft. Later that same day, the LOW started drifting eastward. Waves of about 25 ft were being reported as far south as 50°N; the winds were in the 40-kn gale category. At 0000 on the 3d, the STADT ELSFLETH was sailing westward into 26-ft swells near 52°N, 16°W. The winds were only 30 kn and the seas 10 ft. The storm dissipated on the 4th.

This storm came out of the northwestern Gulf of Mexico. It was first detected on the weather charts on the 29th. It moved northeastward to the Great Lakes and along the St. Lawrence River. The central pressure was 990 mb over the Gulf of St. Lawrence at 1200 on November 1. The storm gained strength as it moved over the Labrador Basin, and the first gales were reported on the 3d. By 1200 it was 972 mb near 56°N, 43°W. The JOHN CABOT was north of St. John's (51°N, 50°W) with 55-kn winds. At 1800 the POLARNYE ZORI was blasted by 70-kn winds from the west and 25-ft seas.

At 0000 on the 4th, the LOW was centered about 400 mi north of Ocean Weather Station Charlie, which was tossed by 50-kn winds and 26-ft seas. At 0600 the winds had decreased to 46 kn. but the waves were now 31 ft. The MAI in the Denmark Strait suffered 60-kn northeasterly winds accompanied by heavy rain. On the 1200 chart, there were reports of 40- to 50-kn winds south and west of the center. The WESER EXPRESS was headed into only 40-kn winds, but the seas and swells were 33 ft near 57°N, 29°W. At 1800 the swells were 43 ft.

On the 5th the high seas and swells extended as far south as OWS C7R, which measured 26 ft as did C7C southwest of the center. By the 7th, the LOW was weakening as it moved toward the continent.

Casualties--The 20,728-ton Liberian tanker CORONA ENERGY dragged anchor in a gale and drifted aground about 6 mi east of Coatzacoalcos breakwater on the 9th. Side-shell plating was heavily damaged, rudder missing, and two anchors lost. The 5,811-ton ATLANTIC EXPRESS broke moorings during bad weather at Rio Haina on the 11th. The vessel drifted and collided with the HICKORY and STRATUS. Vessel sustained severe hull damage. The 8,351-ton Norwegian freighter RYTERHOLM sank during a storm at the entrance to La Coruna Bay on the 12th. The vessel was carrying a cargo of fertilizer which shifted during the storm. Efforts by tug boats to assist failed. One crewmember was missing. The 15,028-ton Panamanian-registered SYLVIA L. OSSA apparently sank about 140 mi west of Bermuda on the 13th. No distress message was heard after the ship radioed the owner that it was reducing speed due to gale-force winds and high seas. Weather reports indicated winds of 40 kn and seas of 12 ft in the area. U.S. Coast Guard and Navy planes searched the area, but no survivors were spotted. A British ship picked up a burned life preserver, and another ship found a lifeboat whose quick-release mechanism had not been tripped. The British motor vessel ALBAN bound for Barbados sustained heavy weather damage and loss of some containers. The 595-ton Cuban cement carrier PRIMERO DE MAYO sank in heavy seas off Caibarien about October 14. The crew was rescued. The 78-ft trawler LANA CAROL sank with a full load of scallops off Barnegat Light on the 31st. The four crewmen were rescued by Coast Guard helicopters and a rescue ship.

Smooth Log, North Pacific Weather

September and October 1976

SMOOTH LOG, SEPTEMBER 1976--The storm tracks off Japan originated off the East Coast in accordance with climatology, but they took a more easterly rather than northeasterly path and ended in the Gulf of Alaska rather than the Bering Sea. Several storms developed over the western Bering Sea and tracked toward the west coast of Alaska and the Bering Strait.

The mean monthly pressure pattern differed considerably from the long-term climatology. There was the primary 1020-mb Pacific High centered near 33°N, 170°W, versus the 1021-mb climatic position near 33°N, 145°W. In addition, there were three subcenters--a 1020 mb near 34°N, 140°W, a 1017 mb near 42°N, 164°E, and a 1016 mb near 47°N, 148°E. The two easternmost centers were the most anomalous. Climatologically, a 1010-mb Low is centered not far away near 54°N, 154°E. The Aleutian Low was normally located near 57°N, 160°W, over Bristol Bay. The pressure was 999 mb versus climatology of 1006 mb.

The largest pressure anomaly was minus 8 mb over Bristol Bay. The negative anomaly pattern extended southward to the Equator roughly between 135° and 155°W. The zero line ran from Hawaii to southern Kamchatka. There were two significant positive centers--a plus 3 mb near 30°N, 180°, and a plus 4 mb over Sakhalin Island.

The upper air was similar to climatology in pattern but more intense. The High over the southern Pacific

was higher, and the Low over the Bering Sea was lower (700 mb). The normal trough over the Bering Strait was replaced by a closed Low over Bristol Bay.

There were three hurricanes, Kathleen, Liza, and Madeline, over the eastern North Pacific. Hurricane Kate formed over the central Pacific. There were four typhoons (Fran, Hope, Iris, and Joan) plus tropical storm Georgia over the western North Pacific.

Extratropical Cyclones--The first severe storm of the month had its beginning over the Yellow Sea on the 2d as a frontal wave. It moved eastward without any significant development until it reached the Kuroshio Current on the 5th. At that time, it started to deepen and develop a closed circulation. At 0000 on the 7th, the 996-mb LOW was near 40°N, 167°E. The FRIBOLL was about 100 mi north of the center with 40-kn easterly winds and 12-ft seas. At 0600 the ALASKA MARU (42.5°N, 164.5°E) and the BREWSTER (44.3°N, 153.4°E) both fought 40-kn gales.

The storm was moving eastward very slowly. The FRIBOLL was following and had 20-ft swells near 41.5°N, 173°E, at 0000 on the 9th. A large high-pressure area was building over the eastern ocean, and the LOW dissipated by the 10th.

This was one of the storms that formed over the western Bering Sea. An area of low pressure tracked up the Sea of Japan into the Sea of Okhotsk. On the 10th, another LOW developed off the eastern coast of the Kamchatka Peninsula. By 0000 on the 11th, it was 984 mb near 58°N, 175°E. The ASIA ZEBRA near 52°N, 174°E, was sailing into 35-kn gales. A station on the southeastern coast of Kamchatka also measured 35 kn. By the 12th, the circulation around the LOW dominated the ocean north of 45°N. At 1200 the MATEMATIK near 60°N, 179°W, had chilling, 40-kn northwesterly winds.

On the 13th, another LOW was moving eastward along the Aleutian Island chain and sapping the strength and circulation of the older system, which disappeared late that day.

This was the LOW mentioned above which helped destroy the older LOW. It formed as a frontal wave off Hokkaido on the 11th. Minimal gales were reported early on the 13th, and by 1200 the SOVETSKIE PROFSOYOUS near 51°N, 179°E, reported 40-kn gales and 12-ft seas. At that time, the LOW was 972 mb near 53°N, 177°W. At 0000 on the 14th, the SHOGEN MARU (50.9°N, 172.6°W) was buffeted by 53-kn winds and 13-ft waves. The ATLANTIC MARU, about 70 mi to the north, had 20-ft swells. At 1800 the UTE (ATF76), at 53.9°N, 158.7°W, was pounded by rain, 50-kn winds, and 20-ft waves.

On the 15th, the 968-mb LOW was over Bristol Bay. At 0000 the ALEUTIAN DEVELOPER was south of Fox Islands with 50-kn winds and 20-ft waves. The ROBERTSBANK had 55-kn winds near 54°N, 153°W. The JPVJ (52.9°N, 141.1°W) radioed 70-kn winds with rain showers. No waves were recorded. At 1200 the PRIOZERSK at 54.2°N, 163.7°W, had 66-kn westerly winds, 13-ft seas, and 20-ft swells. As the LOW moved inland over Alaska, it disappeared.

A rapidly developing secondary LOW formed near 49°N, 162°W, at 0000 on the 17th. By 1800 the GOLDEN ARROW and HILLYER BROWN were reporting 44- and 42-kn winds, respectively, and the ATLANTIC PIONEER (52.7°N, 154.5°W) was battling 50-kn winds and 31-ft seas with 33-ft swells. By 0000 on the 18th, the 972-mb LOW was over Kodiak Island. At that time the PACSTAR was fighting 52-kn winds, 20-ft seas, and 33-ft swells near 54.4°N, 150.8°W. The ATLANTIC PIONEER's winds dropped to 40 kn, but swells remained 33 ft. The JAPAN RAINBOW measured 42-kn winds near 54.1°N, 163.1°W. The storm slowly drifted over Bristol Bay and began to fill rapidly. It dissipated on the 20th.

This storm formed late on the 22d near 37°N, 158°W, south of another LOW as a frontal wave. At 0600 that day, the JAPAN BEAR (43.0°N, 141.5°W) measured 50-kn gales and 17-ft swells. At 1200 on the 23d, the LOW was 990 mb near 41°N, 149°W. The ALEUTIAN DEVELOPER (56.8°N, 153.5°W) was contesting 40-kn gales and 20-ft waves. Late that day, the new circulation absorbed the older one and intensified considerably to 970 mb by 0000 on the 24th at 50°N, 145°W. The ASIA BOTAN at 45.5°N, 164.3°W, fought 44-kn winds. At 1200 on the 24th, the ALEUTIAN DEVELOPER was again involved with 50-kn northeasterly winds and 20-ft swells. On the 25th, the ASIA BOTAN was still contesting 40-kn winds.

On the 26th, the storm moved inland over the Alaska Peninsula and dissipated, while extratropical Joan moved south of it.

The last significant storm of the month developed south of Honshu on the 27th. On the 28th, the HAGOROMO MARU (35.4°N, 150.8°E) had 45-kn easterly gales north of the center. The PRESIDENT TRUMAN was pounded by 60-kn winds and 20-ft seas near 38°N, 143.7°E, and the VERMA was also hit by 60-kn winds in the same area at 0000 on the 29th. The vessel did not report the wave heights. Several vessels reported winds in the 40- to 50-kn range on the 28th and 29th.

The storm was on an east-northeasterly track. At 1200 on the 29th, the KASHIMA MARU near 45°N, 159°E, had heavy rain and 45-kn winds. At that time, the 972-mb LOW was near 43°N, 156°E. The LOW continued to deepen and was 964 mb by 1200 on the 30th. The PEARL VENTURE, which had winds of 44 to 48 kn in this storm on the 28th and 29th, reached 50 kn with 13-ft seas and 26-ft swells at 0600 on the 30th at 42.2°N, 164.5°E. The KASHIMA MARU was sailing eastward with the storm and now had 50-kn gales on her stern with 13-ft seas. Pounded by 10-ft seas and 21-ft swells, the anemometer reached 58 kn on the ASIA BRAVERY (44.4°N, 173.7°E) at 1800 on the 30th.

On October 1, a ship 200 mi south of the center was sailing into 45-kn winds and 25-ft swells. The PEARL VENTURE was now over 600 mi south of the 958-mb center, near 53°N, 176°E, with 50-kn winds and 21-ft swells. At 1800 on the 30th, the barometer on the MAMMOTH PINE bottomed out at 970 mb as the storm passed to the north. With barometer rising, she was pounded by 90-kn southwesterly winds at 0000 on the 1st and 85 kn at 0600. The seas were 41 ft and the swells 39 ft. The MAMMOTH PINE was sailing westward with the storm and had winds of over 40 kn until 1200 on the 2d. The seas ran up to 33 ft and the swells to 39 ft. At 0000 on

the 2d, the LOW was 960 mb near 53°N, 180°. A SHIP near 49°N, 176°E, plotted 55-kn winds, 10-ft seas, and 46-ft swells (code 28), but the swells probably were 13 ft (code 08). About 250 mi to the south, the HASHIMA MARU had 45-kn gales and code 6 and 7 seas and swells.

At 0000 on the 3d, the 973-mb storm was near 52°N, 174°W. The GEORGIANA (48°N, 179°W) had 16-ft seas and 20-ft swells. The TOYOTA MARU (49°N, 175°E) had 40-kn winds and 25-ft swells.

The storm started filling, and the gradient began weakening on the 4th; by the 6th, it had disappeared.

Tropical Cyclones, Eastern Pacific--Kathleen began as a tropical disturbance 300 mi southwest of Acapulco on the 6th. Moving west-northwestward, the disturbance was upgraded to a tropical depression at 0600 on the 7th. Winds increased to 35 kn the following day, and the depression was upgraded to a tropical storm with a center still about 360 mi southwest of Manzanillo. Winds on Socorro at 0600 were from the east at 30 kn; by 1200 they had shifted to the southeast at 45 kn with Kathleen now 130 mi south of the Island. Winds on Socorro increased to 50 kn as Kathleen passed 60 mi to the west at 0300 on the 9th. At 1800 the PRUDENTIAL SEASET found 45-kn winds; at 2400 winds were 43 kn, seas 13 ft, and swells 18 ft. Moving north-northwestward, Kathleen passed over the western edge of an area of very warm water (in excess of 86°F) off the southern tip of Baja California. Evidently drawing additional energy from the warm water, Kathleen began to intensify and accelerate northward.

The storm was upgraded to hurricane intensity with 70-kn winds at 0000 on the 10th. At 0046 an Air Force reconnaissance aircraft located the center at 25.3°N, 114.8°W, with estimated surface winds of 80 kn and a central pressure of 986 mb. A second flight through the hurricane at 0145 estimated the surface winds at 55 kn and the central pressure at 990 mb. At 0600 on the 10th, hurricane Kathleen was downgraded to a tropical storm again.

Kathleen moved rapidly northward at 30 to 33 kn and crossed the western tip of the Point Eugenia Peninsula on the west coast of Baja California between 0700 and 0800 on the 10th. At 1130 the storm moved onshore 140 mi south of Ensenada and continued northward over the Sierra San Pedro and Juarez mountains. Kathleen crossed into southern California by midmorning and was centered near Calexico at 1800. By late afternoon the storm had moved over Death Valley and then into western Nevada, about 140 mi southeast of Reno, by 0600 on the 11th. Thereafter, the center was difficult to locate, but gusty winds and rain continued to spread northward into eastern Oregon, Idaho, Montana, Utah, and Wyoming.

The first rain to appear over the southern California desert areas began early on the 9th. By evening, moderate rain was reported at Imperial, Calif. By the morning of the 10th, the rain had spread to western Arizona, southwest Utah, southern Nevada, and as far north as Fresno and Bishop, Calif. Imperial, Calif., reported a surface pressure of 997.3 mb at 1800. Yuma, Ariz., reported the highest wind--66 kn. As the storm continued northward through Death Valley and into western Nevada, it was joined by a low-pressure system moving inland from the southern California coast. This low-pressure system brought additional rain inland over the coastal and interior valleys of central California.

Kathleen left 10.78 in of rain on Mount Wilson, just north of Los Angeles; 14.5 in on San Gorgonio Mountain, northwest of Palm Springs; and 10.13 in on Mount Laguna, east of San Diego. Lake Arrowhead, east of Los Angeles, reported a storm total of 8.71 in. The civic center in downtown Los Angeles reported 1.98 in to bring the season's total to 2.3 in compared to a normal of .06 in for the date.

In the desert, Imperial reported a storm total of 2.22 in; Yucca Valley, 3.36 in; and Palm Desert, which normally receives only 2 in per yr, received 3.57 in. Hardest hit by the storm was the desert town of Ocotillo, about 25 mi west of El Centro near the California-Mexico border. A wall of water moving down Myer Canyon destroyed the Myer Creek Bridge on Interstate Highway 8 causing a gap 700 ft wide and 10 ft deep through the highway. The wall of water, estimated to be one-half mi wide and 4 to 6 ft high, destroyed 70 percent of the homes in Ocotillo and severely damaged another 20 percent. Three deaths were reported, and at least 100 people were evacuated.

Flood waters rushing into the Salton Sea raised its level 6 to 8 in. Several seaside communities were flooded, and at least 75 people were evacuated from Salton City. The New River, flowing from Brawley to the Salton Sea, overflowed its banks when silt carried by the river backed up at its mouth. The river, normally 20 ft wide, swelled to more than one-fourth mi. Flood waters moving through the Carrizo Gorge northeast of Jacumba destroyed three bridges and several miles of track of the San Diego-Arizona Eastern Railway.

Agricultural losses in the Imperial Valley exceeded $60 million. Sand, silt, and mud carried by flood waters changed the topography and ruined much of the farmland and destroyed most of the elaborate irrigation systems necessary for desert farming. In the San Joaquin Valley of central California most of the raisin crop was destroyed along with late varieties of fruit and nuts; the loss was estimated in excess of $100 million.

In summary, Kathleen, the first tropical cyclone to hit southern California in 37 yr, left five dead in the United States: three in Ocotillo, one in San Bernardino County, and one in Yuma, Ariz. At least 175 people were evacuated from flooded areas, and losses were estimated in excess of $160 million.

In the waning days of the month, Liza was born a few hundred miles southeast of Kathleen's birthplace. By the 26th, near 14°N, 108.5°W, she was christened. Two days later, Liza blew at hurricane force and was making her way northward. Winds climbed as pressure fell. Late on the 29th, winds reached 100 kn, and the following day they peaked at about 115 kn. Ships in the area, including the RICE QUEEN, CRAFTON, OAKLAND, and INGER were reporting winds up to 60 kn and fighting waves to 33 ft. The center of Liza brushed the coast of Baja California on the evening of the 30th. The wind and rain were responsible for widespread damage over the peninsula. La Paz, the capital, was particularly hard hit (fig. 48). The rain-swollen Cajoncito River broke through a shoddily-constructed dike. Most of the estimated 600 to 1,000 deaths were caused by this flood.

Figure 48.--Survivors of hurricane Liza sit amidst the ruins of their home in La Paz, Mexico. Wide World Photo.

As Liza traversed the Gulf of California on her northward journey, she whipped the FAIRSEA, HARRY LUNDEBERG, and the FNSQ with 40-kn winds and seas up to 25 ft. Liza dropped below hurricane force and moved inland near Yavaros on October 1.

The initial impetus for hurricane Madeline was detected near 10°N, 90°W, late on the 28th. However, it was not until October 3, near 11°N, 96°W, that she started to organize. Two days later, the westward-wandering depression reached tropical storm strength. She then turned northwestward. Late on the 6th, Madeline became a hurricane near 13°N, 100°W. A ship 150 mi to the east encountered 45-kn winds in 20-ft swells. On the 7th, the NORSE VIKING, sailing about 120 mi northeast of the center, encountered 40-kn winds at 1200 and 60-kn winds 12 hr later. The ECUADORIAN REEFER fought 56-kn winds and 25-ft seas within 60 mi of the center. The AUSTRAL LIGHTNING first encountered storm winds of 55 kn at 2100 on the 7th at 16.5°N, 100.4°W, as she sailed on a northwesterly course. The winds built to 99 kn by 0600 on the 8th with 25-ft waves, and the pressure was 970.2 mb. At that time she was about 50 mi northwest of the center. It was not until 1800 that the wind dropped to gale force. The MEONIA appeared to pass even closer to the storm's center at 0700 on the 8th, when her barometer registered 960 mb. There was no 0600 observation, but at 0000 the winds were 45 kn and at 1200 50 kn. The highest waves recorded were 16 ft. Madeline was moving due north on a collision course with Mexico. Maximum winds were estimated at 100 kn on the 7th and 125 kn on the 8th before she moved ashore about midway between Manzanillo and Acapulco. On the 8th, the LASH ESPANA reported 55-kn winds and 20-ft swells at 0000 and 1200. The FINN LEONHARDT, also rolling in 20-ft swells, reported 41-kn winds. Madeline passed over the mouth of the Balsas River and began to dissipate as she continued farther inland.

In late September, Kate became the first central North Pacific tropical cyclone. She was detected near 12.7°N, 140.7°W, on the 21st. Kate reached tropical storm strength the following day and drifted aimlessly. On the 23d, she began moving slowly northwestward toward the Hawaiian Islands. Kate reached hurricane strength on the 24th, but she was still meandering. At 0000 on the 25th, her center was at 14.1°N, 142.8°W. Maximum winds climbed to 90 kn with gales extending out 200 mi on the 26th. Her intensity decreased somewhat as she headed west-northwestward, then northwestward, at about 5 kn. At 0000 on the 28th, Kate's center was spotted near 18.2°N, 146.6°W. At this time, she was beginning to accelerate and was a threat to the Islands. For a while she swung toward the west-northwest on a collision course, but two things happened--Kate weakened to tropical storm strength, and she returned to a northwesterly course away from the Islands. Late on the 29th the HAWAIIAN PROGRESS was caught in Kate's circulation and was hit by 42-kn winds and 17-ft seas near 23.9°N, 152.3°W. By the 30th at 0600, Kate was near 23.5°N, 152.6°W.

Figure 49.--The tanker RYOYO MARU, split in two, lies helpless off southern Japan. Wide World Photo.

Tropical Cyclones, Western Pacific--Supertyphoon Fran was one of the most destructive storms to strike Japan in more than a decade. The preliminary death toll stands at 114 with another 50 people missing. The devastating storm crashed through the Ryukyu Islands, near Okinawa, on the 9th. Then she stalled for 2 days just south of Kyushu, pounding southern Japan with strong winds and torrential rains. Fran finally moved across the western part of the island and into the Sea of Japan on the 12th. Most of the damage and death resulted from the prolonged period of heavy rains. Five-day totals of 60 in, more than Tokyo's average annual amount, fell over areas of western and central Japan. Hardest hit was Kochi City, where rivers flooded after 50 in of rain. Throughout Japan, floods swept away 221 bridges and caused 3,577 landslides. Fran was also held accountable for the 138 vessels that were either sunk or damaged.

The typhoon formed along the northern edge of the Caroline Islands on the 3d. Moving northwestward, she passed over Guam as a tropical storm on the 5th. The following day Fran was at typhoon strength. An indication of her intensity was reported by the 30,372-ton Polish freighter UNIWERSYTET TORUNSKI. Steaming about 300 mi northeast of the center, she estimated easterly 80-kn winds at 0600 on the 6th. This may have been a little high; 6 hr later, about 360 mi northeast of Fran's center, the freighter reported 56-kn winds from the east. The ship, steaming southward, had a few days of grace before encountering Georgia. Fran peaked from late on the 7th to early on the 8th when estimated maximum winds climbed to 135 kn. Gales extended out 200 to 300 mi. Fran was threatening the Ryukyus. She weakened considerably before attacking the Islands and Japan. At sea she was still potent. The PRESIDENT MADISON (26°N, 127.7°E) bucked 45-kn winds and 20-ft seas on the 9th. On the 10th and 11th, many ships encountered 40- to 50-kn winds in Fran. On the 12th the STRATHARDLE and the WILD FULMAR, both about 200 mi southeast of the center, encountered 45- to 50-kn winds in 25- to 30-ft swells.

Typhoon Fran claimed three casualties. The 52,157-ton Japanese tanker RYOYO MARU suffered a V-shape break amidships in the Bungo Strait (fig. 49) and anchored off Saeki. All 62 crewmembers were rescued after taking to lifeboats. The 23,089-ton British bulkcarrier EASTERN FREEDOM broke all aft moorings at Pohang, damaging propeller and rudder and a Korean naval vessel. The 2,556-ton Panamanian freighter JICS ran aground during the typhoon at Tio-

jima, Minamata Bay.

At 0000 on the 14th, extratropical Fran was near 41°N, 135°E. Several ships reported gale-force winds. The EWTI fought 50-kn winds, 26-ft seas, and 27-ft swells at 41.9°N, 142.1°E. At 42.2°N, 141.9°E, the EOHE found 46-kn winds and 20-ft seas. At 0600 the TOURKOUL at 42.3°N, 141.6°E, had 40-kn gales and 23-ft seas. Also, a ship identified as URPS fought 60-kn winds and 31-ft seas near 45.5°N, 138.3°E. The storm was raising havoc with the Soviet fishing fleet. The TCHERNOVTSY caught 48 kn at 1200.

On the 15th, two ships reported 40-kn gales over the Sea of Japan. Later that day, the LOW turned eastward into the Pacific and died.

While Fran was wreaking havoc in Japan, Georgia attempted to follow in her wake. On the 9th, she formed a few hundred miles east of where Fran began. She reached tropical storm strength the following day, while heading west-northwestward. At 0000 on the 10th, the UNIWERSYTET TORUNSKI, after a brief respite from Fran, ran into 40-kn northwesterlies 120 mi southwest of Georgia's center. Six hours later, she reported westerly 64-kn winds. However, Georgia's maximum winds were estimated at 50 kn, and she was never upgraded to typhoon strength. On the 13th, she ran into a brick wall around the 15th parallel. Typhoon Fran and a ridge of high pressure kept Georgia confined to the Tropics. She meandered eastward looking for an opening but weakened before she found one east of the southern Marianas. The FOLLIS encountered 42-kn winds late on the 14th south of the center of the dying storm. Early on the 15th, Georgia was absorbed into the circulation of tropical storm Hope, which had sprung to life near 18°N, 153°E, earlier in the day.

An unidentified ship just east of Hope's center encountered 45- to 50-kn winds in 15- to 25-ft seas on the 14th. At the same time the COLORADO, west of Palawan in the South China Sea, was battling 45-kn winds in 18-ft seas. This was a clue that Iris was flowering to the north, off Luzon. Hope moved northward and reached typhoon strength by the 15th, while Iris meandered northwestward at tropical storm strength. On the 15th, the CAPE YORK encountered 48-kn winds in 25-ft seas near Hope's center and again found the same conditions a day later more than 300 mi to the southeast of her center. The HONG KONG PHOENIX was headed westward toward Hong Kong. Her speed and course would take her due north of Hope by about 0000 on the 16th. Her closest point of approach was 223 mi at 1800 on the 16th when she was northwest of the center. The lowest barometer reading was 996 mb at 2200 (fig. 50). The strongest winds were 35 kn at 0000 on the 17th. At that time and 1800 on the 16th, she had 30-ft swells. Hope's maximum winds reached 70 kn before she began to weaken and turn extratropical on the 17th as she crossed 40°N, heading north-northeastward. Meanwhile, Iris was getting it together as she reached typhoon strength on the 17th near 18°N, 116°E. Earlier, both the 7JBU and the WAKAURA MARU encountered 40-kn winds in 20- to 25-ft seas. Iris turned west-northwestward toward China. On the 18th her winds peaked at 75 kn. Iris reached the coast near the Luichow Peninsula the following day. Once inland, she weakened rapidly.

Typhoon Iris claimed the 3,903-ton Panamanian freighter CHIEH LEE, which sank in the South China Sea 200 mi east of Hong Kong. An air-sea search failed to locate 11 crewmen. Thirteen of the crew, floating in lifejackets, were rescued by the Danish freighter EMMA JEBSEN. Four others were known dead. At Hong Kong, the 18,476-ton Liberian tanker

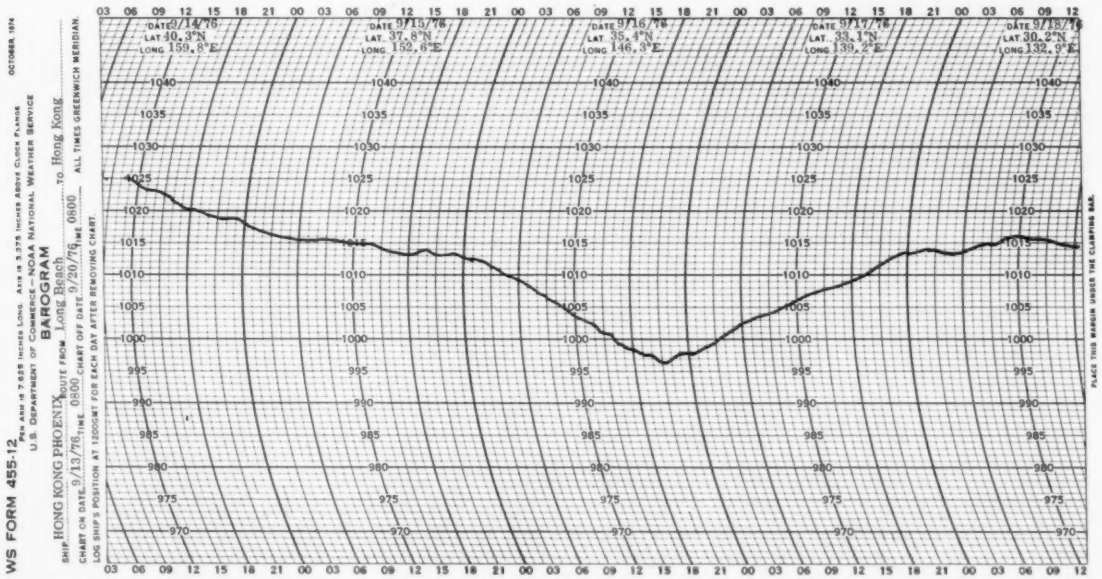
WS FORM 455-12
OCTOBER 1974
U.S. DEPARTMENT OF COMMERCE—NOAA NATIONAL WEATHER SERVICE
BAROGRAM
SHIP HONG KONG PHOENIX ROUTE FROM Long Beach TO Hong Kong
CHART ON DATE 9/13/76 TIME 0800 CHART OFF DATE 9/20/76 TIME 0800 ALL TIMES GREENWICH MERIDIAN
LOG SHIP'S POSITION AT 1200GMT FOR EACH DAY AFTER REMOVING CHART.
DATE 9/14/76 LAT 40.3°N LONG 159.8°E
DATE 9/15/76 LAT 37.8°N LONG 152.6°E
DATE 9/16/76 LAT 35.4°N LONG 146.3°E
DATE 9/17/76 LAT 33.1°N LONG 139.2°E
DATE 9/18/76 LAT 30.2°N LONG 132.9°E
PLACE THIS MARGIN UNDER THE CLAMPING BAR.

Figure 50.--Barograph from the HONG KONG PHOENIX shows the pressure dropped to 996 mb at 2200 on the 16th as typhoon Hope passed south of the vessel.

OLYMPIC DALE went aground at Junk Bay.

By 0000 on the 18th, a warm front had penetrated to the center of Hope, and she became extratropical near 46°N, 150°E. As she was turning extratropical on the 17th, many ships reported winds of 40 to 50 kn. On the 18th ships continued to feel the sting of extratropical Hope with the SHUNWIND battling 65-kn winds and waves of 26 ft near 49.5°N, 161.6°E. The ARCTIC TOKYO was among these, starting with 46-kn winds at 0000 near 49°N, 156°E. Between 1200 and 1800 the winds were 50 kn and shifting from southerly to southwesterly as the ship passed south of the center. The barograph dropped to 973 mb before starting to rise.

At 0000 on the 19th, a SHIP was battered by 16-ft seas and 25-ft swells near 47.5°N, 160°E. The LOW was weakening by the 20th, but the PRESIDENT FILLMORE was buffeted by 50-kn winds and 16-ft waves. On the 21st, the storm absorbed another LOW and found new life. On the 22d, the JAMSONS was hit by 50-kn northerly winds, 34-ft seas, and 25-ft swells near 50.8°N, 172.7°W.

The LOW continued moving eastward and was absorbed by another LOW on the 24th.

While Iris faded over China, Joan came to life about 100 mi east of where Hope had formed. Joan became a typhoon for a day as she headed northward. Her big moment arrived on the 21st when she was crowned a typhoon by the Joint Typhoon Warning Center at 1200. Winds climbed briefly to 70 kn, but her reign ended at 0000 on the 22d when she was downgraded to a common tropical storm. The AMERICAN ARCHER found 50-kn winds in Joan's circulation early on the 22d near 24.9°N, 153.7°E (fig. 51). The following day Joan turned north-northeastward and became extratropical early on the 24th.

Figure 51.--Joan (lower left) was a weak storm, while extratropical Hope (upper right) was still kicking up her heels on the 22d.

Joan was still a powerful storm, however. At 1200 on the 24th, a ship encountered 26-ft seas and 24-ft swells within a few miles of the 972-mb center. On the 25th, the storm was racing eastward. On the 25th and 26th, there were no significant wind or wave reports, but there were several on the 27th. The configuration and central pressure of the storm remained about the same. The JAPAN ACE was battered by 40-kn winds and 28-ft swells near 38°N, 150°W, at 0000 on the 27th. At 1200 the SEA-LAND EXCHANGE at 37°N, 146°W, encountered 45-kn winds with the swells running 23 ft.

The LOW had turned southeastward late on the 26th and moved off the coast of California. It finally went ashore near San Diego late on the 29th.

Casualties--The 17,342-ton American PRESIDENT GRANT ran aground outside Keelung Harbor breakwaters on September 1. On the 8th, she was temporarily refloated with the aid of swell from typhoon Fran, but she regrounded. Salvors equipment from Manila was delayed by typhoon Iris. Efforts to refloat were abandoned late in the month, and the ship was declared a total loss.

The Indian bulkcarrier KOLANDIA, Vancouver for Singapore, with a cargo of wheat reported heavy weather damage between Vancouver and Hawaii.

SMOOTH LOG, OCTOBER 1976--The cyclone tracks this month were slightly below normal in number. Over the western ocean they followed the normal climatological paths except for a slight grouping near the northern tip of Sakhalin Island as the result of two Sea of Japan storms that tracked northward into that area. There was also a crowding of storm paths in the vicinity of Adak Island as storms approached from the west to the south. There were fewer storms in the Gulf of Alaska than normal. The storms that normally originate near midocean and track northeastward into the Gulf originated farther east and south this month and tracked toward British Columbia.

The pressure pattern closely resembled the long-term mean except for some slight shifting of centers. The Aleutian Low matched the climatic mean of 1001 mb pressure, but it was centered near the Fox Islands rather than slightly northeast of Kodiak Island. There was an anomalous 1007-mb Low center over the Sea of Okhotsk. The large Pacific High closely matched its climatological counterpart with two centers. There was a 1020-mb center near the normal 1019-mb center of maximum pressure near the central ocean. A 1021-mb center that was 2 mb higher than normal was northeast of its counterpart and near 39°N, 133°W.

The primary anomaly centers were alined east-west across the northern ocean near 50°N. A 6-mb negative center was over the Sea of Okhotsk, and another 6-mb negative center was near 50°N, 175°W. A positive 7-mb center completed the alinement south of Sitka.

The upper-air pattern and wind flow were more intense than normal. A closed Low center replaced the normal trough over the eastern Bering Sea. A pronounced ridge separated that Low center from another over the Sea of Okhotsk. The ridge over the Rocky Mountains was higher than normal. The anomaly centers matched the surface centers in both location and

pressure differences from the climatic normal.

There were only two tropical cyclones this month--tropical storm Naomi over the eastern waters and typhoon Louise over the western ocean.

Extratropical Cyclones--This frontal wave first appeared on the 0000 chart of the 3d near 38°N, 167°E. It traveled eastward at about 35 kn under the upper-air zonal flow and started deepening on the 4th. Late that day it turned northeastward. At 1800 on the 5th, the VAN TRIUMPH was about 120 mi east of the center with 64-kn southerly winds. At 0000 on the 6th, the 972-mb center was near 50°N, 150°W. At 0600 the TEKHNOLOG, at 53.3°N, 148°W, was very near the center fighting 58-kn winds from the south and 21-ft seas. On the 7th the storm moved ashore near Valdez.

As an Arctic front overtook a Polar front east of Japan late on the 5th, a frontal wave formed and intensified near 36°N, 153°E. The VEMA (34.2°N, 152.1°E) had 45-kn westerly winds at 0600 on the 6th. By 0000 on the 7th, the LOW was 987 mb near 43°N, 165°E. The CAIRNSMORE was about 300 mi south of the center with 50-kn west-northwesterly winds and 16-ft waves. The ALASKA MARU was within 100 mi of the center with a pressure of 988.5 mb and 40-kn winds.

Early on the 8th, the LOW crossed north of the Aleutian Islands near 180°. The center of the LOW passed very close to the ATLANTIC PIONEER, and she measured 50-kn winds with 30-ft seas and swells. At 0600 the ADRIAN MAERSK (48°N, 176.8°E) braved 56-kn southwesterly winds and 26-ft seas with visibility reduced to 1 mi. On the 9th the LOW reached its lowest pressure of 980 mb near Adak Island. The storm crossed the Alaska Peninsula into the Gulf of Alaska late on the 9th. On the 11th it went ashore on the southern shore of Alaska and disappeared.

This storm closely followed the climatological storm track that extends from south of Japan into the Bering Sea. It was first analyzed at 0000 on the 9th. By 1800 on the 10th, the OVERSEAS JUNEAU was battered by 17-ft seas and 39-ft swells at 39°N, 151.4°E. It was developing into a large, 978-mb storm moving northeastward east of the Kuril Islands. Six hours later, the OVERSEAS JUNEAU measured 55-kn winds, 20-ft seas, and 33-ft swells. The storm was centered near 43°N, 153°E. The PRINSENDAM was within 30 mi of the center with the barometer reading 980 mb. The winds were not exceptionally strong, but the seas were 16 ft. What hurt were the 46-ft swells that were pounding the ship. The YANA was west of the center with 52-kn winds, and the MEISHUN MARU was north of the center with 55 kn. At 0600 the GIBRALTAR MARU (39°N, 161.6°E) had 33-ft swells. At 1200 another ship, near 41°N, 162°E, stared into 30-ft waves that continued into the next day.

At 1200 on the 12th, the 964-mb storm was crossing into the Bering Sea. The YOZAN MARU, 450 mi southwest of the LOW, had been taking 54-kn winds and 26-ft seas and swells on her starboard side. The LOW was moving slowly across the Bering Sea. Gale-force winds were blowing along the coastal stations, and isolated ship reports indicated seas up to 25 ft. On the 15th the LOW started breaking down rapidly, and it disappeared by the 16th.

This storm was a Japanese export. It was shipped from northern Honshu late on the 14th. On the 16th there were two reports of 16-ft waves. At 1200 the 986-mb LOW was near 47°N, 169°E. The storm was moving almost due east with generally gale-force winds. At 1800 on the 17th, the HARFLEET (40.7°N, 179°E) was sailing into 33-ft swells. The NORTHERLY TRADER was only about 60 mi from the center at 0000 on the 18th with 20-ft seas and 28-ft swells. Twenty-four hours later she still had 26-ft waves. On the 19th the storm headed northward south of Dutch Harbor; it dissipated near the Pribilof Islands on the 20th.

This was mainly an inland sea storm. It originated over the East China Sea on the 19th. On the 20th it was moving over the Sea of Japan, and by 0000 on the 21st had merged with another LOW coming out of Manchuria. At that time it was 974 mb near 46°N, 142°E. Several Russian ships in the vicinity of the Kuril Islands reported 50-kn winds. At 0600 the KOREAN MAIL (43°N, 147°E) was bounced by 55-kn winds and 28-ft seas. At 1800 the VASSILII BLIOUKHER, at 42.4°N, 143.7°E, fought 62-kn winds. At 0000 on the 22d, the 968-mb LOW was over northern Sakhalin Island. Late that day it turned eastward, then southward, as it rapidly filled on the 23d.

A LOW formed at the point of occlusion of a front on the 26th near 38°N, 168°E. Earlier at 0600 on the 25th, the ASIA BRAVERY (44.6°N, 153.2°E), east of the LOW with which the occlusion developed, encountered 50-kn winds from the southeast with 35-ft seas. It was 60 hr after the LOW formed on the occlusion that it started to deepen significantly. At 0000 on the 29th, it was 990 mb near 46°N, 173°W. Two ships reported 21-ft swells. At 1200 the pressure was 970 mb. No ships reported in the normally high-wind southwest quadrant. By 0000 on the 30th, the LOW was near 51°N, 148°W, at 962 mb. The SRETENSK, near 48°N, 150°W, battled 46-kn winds blowing 33-ft seas from 280° with 33-ft swells from 240°. The SINCERE, 250 mi northwest of the center, fought 52-kn northerly winds. At 0600 the CHITA MARU, 180 mi to the south, topped the others with 60 kn. At 1200 the SRETENSK was still having problems with 30-ft seas and 33-ft swells. The VANCOUVER, near 50°N, 140°W, was sailing into 34-ft swells. At 56°N, 148°W, the PHILADELPHIA was rolled by 60-kn winds, 20-ft seas, and 41-ft swells 40° from the winds and seas. Her sea-level pressure was 963.8 mb, but another ship, the CHADRINSK, reported 957.8 mb even closer to the 956-mb center. The winds and seas were light, but the swells were 16 ft. High seas and swells favored the southeast quadrant at this time. By November 1, the storm quickly broke up as it moved into Cook Inlet.

Early on the 30th, the area around Korea, southern Japan, and the East China Sea was covered by a weak pressure gradient. By 1200 a LOW had formed over Korea. The center moved over Hokkaido late on the 31st. At 1200 on November 1, the central pressure had decreased to 985 mb. The RADE KONCAR, at 38.2°N, 148.2°E, was caught in 74-kn thunderstorm winds. At 1800 the PETR ILICHYOV reported 58-kn

westerly winds at 45°N, 148°E. The BREWSTER found 60 kn farther south at 41.4°N at 0000 on the 2d. At 1200 the HAKUZAN MARU had 33-ft swells pounding her starboard side at 44.6°N, 159°E. At 0000 on the 3d, the PACBARON, near 49°N, 162°E, fought 55-kn winds, 20-ft seas, and 23-ft swells. By 1200 the LOW was 970 mb near 54°N, 175°E.

The 0000 reports on the 4th indicated two ships with seas and swells up to 26 ft south of the center. They were also reporting 45- and 55-kn winds. At 1200 the NISSHIN MARU reported 44-ft seas in the vicinity of 52.5°N, 170°E, as the storm was breaking up.

Tropical Cyclones, Western Pacific--Louise was born in the Caroline Islands on the 30th. By the 1st she was a full-fledged typhoon. Moving west-northwestward, she continued to intensify. Before the 2d was through, Louise was a supertyphoon. Winds of 135 kn blew around her center, which was located near 14°N, 131°E. Gusts were estimated at 165 kn and gales extended out 375 mi in the northern semicircle and 175 mi to the south. Louise gradually recurved to the north, then to the northeast. She remained about 250 mi east of the Philippines and 150 mi off the Ryukyu Islands. Louise crossed the 20th parallel near 127°E late on the 4th. She remained at super strength (130 kn) through the 4th, and winds stayed above 100 kn until late on the 6th as she approached the 30th parallel near 137°E.

On the 5th the ASIAN RENOWN, HOLLANDS BURCHT, and the AKADEMIK KOROLYOV all encountered 35- to 40-kn winds far north of the center; the HOLLANDS BURCHT also reported 26-ft swells. By this time she was turning extratropical. On the 7th Louise was a potent extratropical storm.

Tropical Cyclones, Eastern Pacific--Naomi, the fourth tropical cyclone to hit the west coast of Mexico this season, was first detected near 15°N, 115°W, on the 25th. This was farther west than the other three (Kathleen, Liza, and Madeline). Naomi moved northward, then northeastward. Maximum winds reached 45 kn on the 27th as she traveled through the Islas Revilla Gigedo. The MARCONA EXPORTER encountered 43-kn winds, 10-ft seas, and 15-ft swells at 21.8°N, 110.6°W, at 2100 on the 28th. Early on the 29th, Naomi passed 100 mi south of Baja California on her way to Mazatlan on the Mexican mainland. Before the day was over, she was breaking up in the Sierra Madres.

Casualties--The 6,753-ton GREAT GLORY encountered heavy weather on the 1st enroute from Tampa to Japan. The vessel deviated to Honolulu and arrived on the 29th.

The ORIENTAL FINANCIER arrived at Yokohama about the 27th with two survivors of a pleasure craft that sank on a trip from Hawaii to San Francisco. A man and woman of five passengers were spotted adrift in a liferaft on the 19th. Their boat had sunk 3 weeks earlier. The Panamanian freighter LAKELAND (2,376 tons) went aground in rough seas off Tenno of Akita Prefecture.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

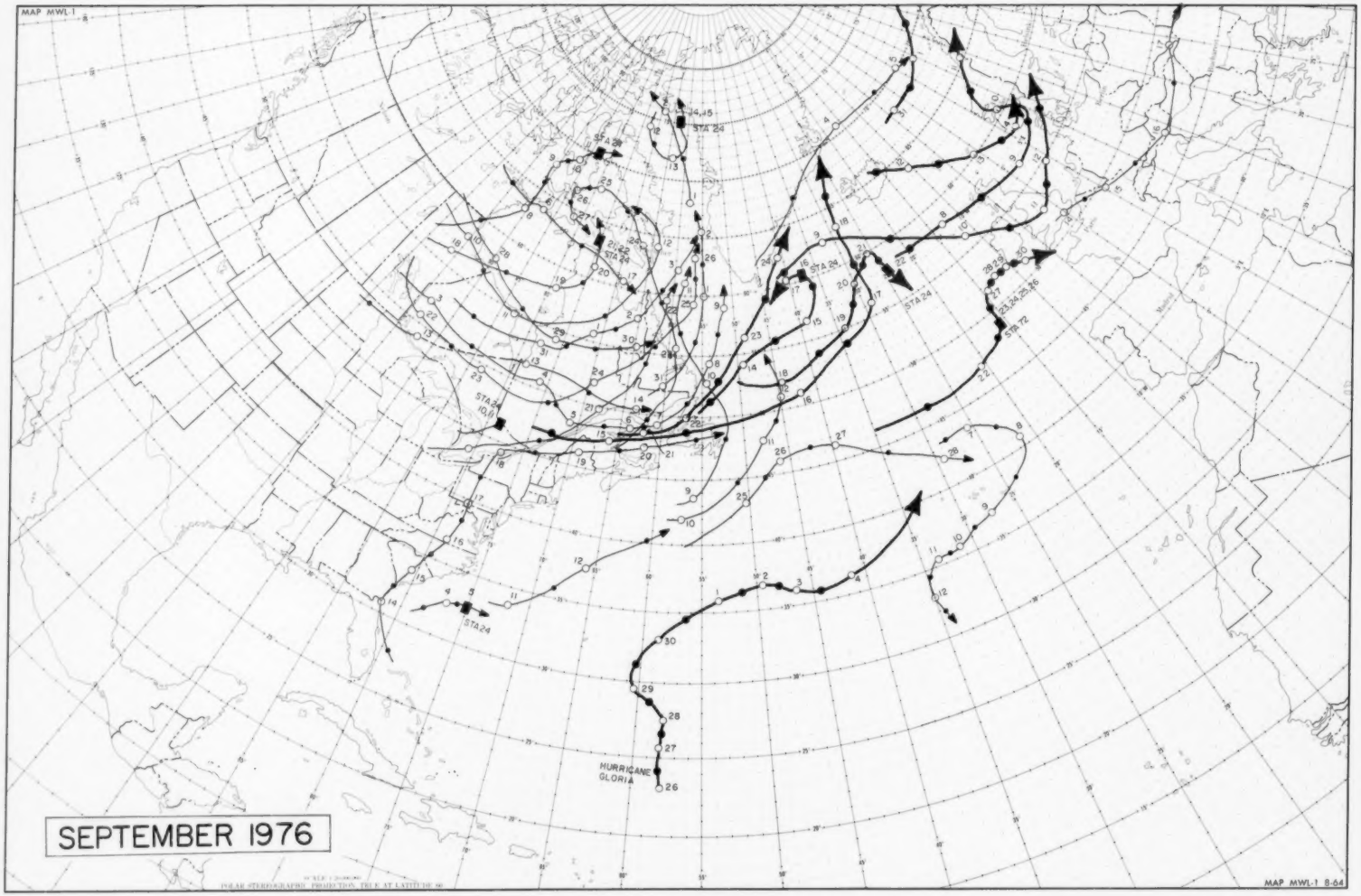

Figure 52. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

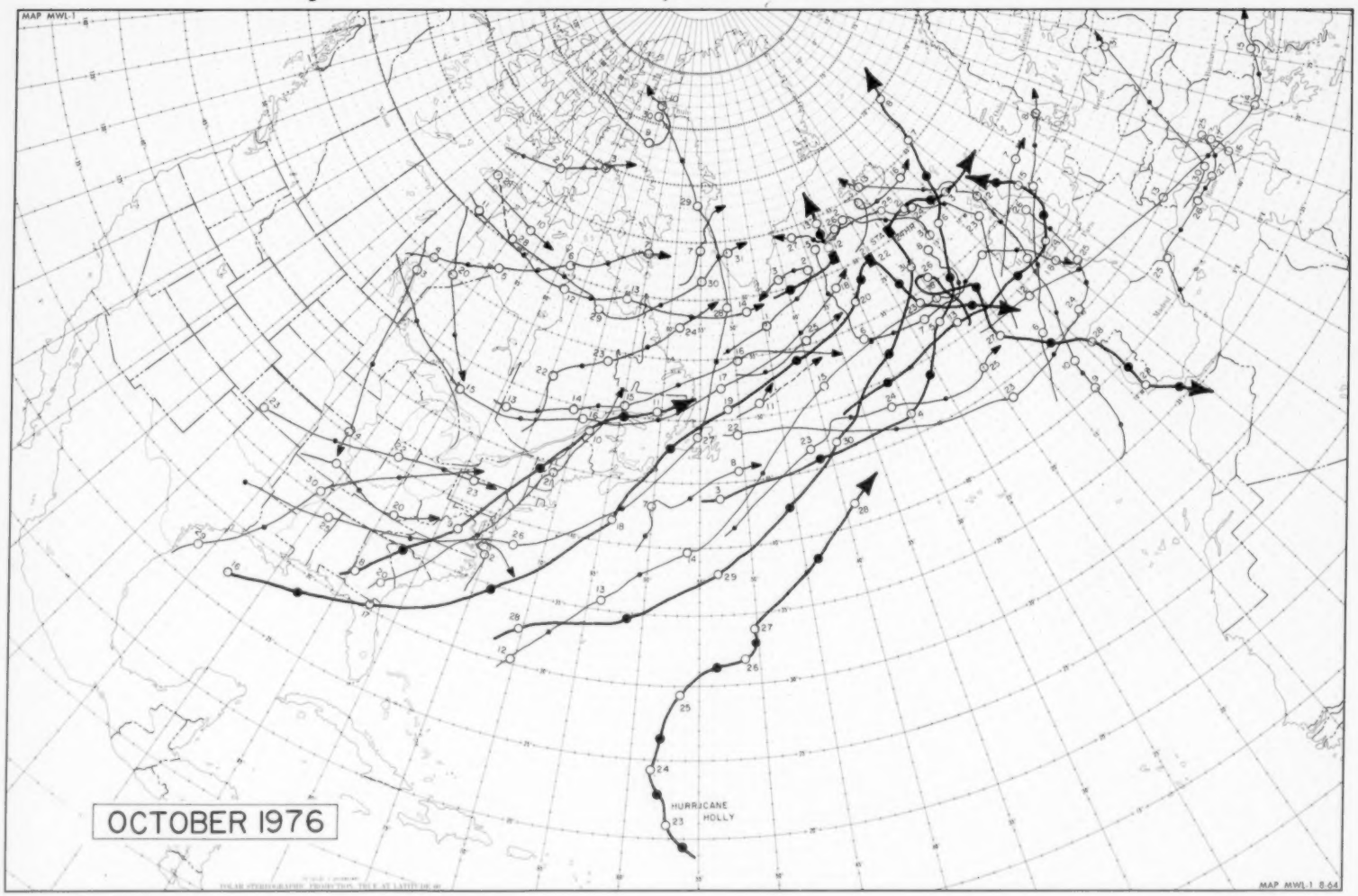

Figure 53. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

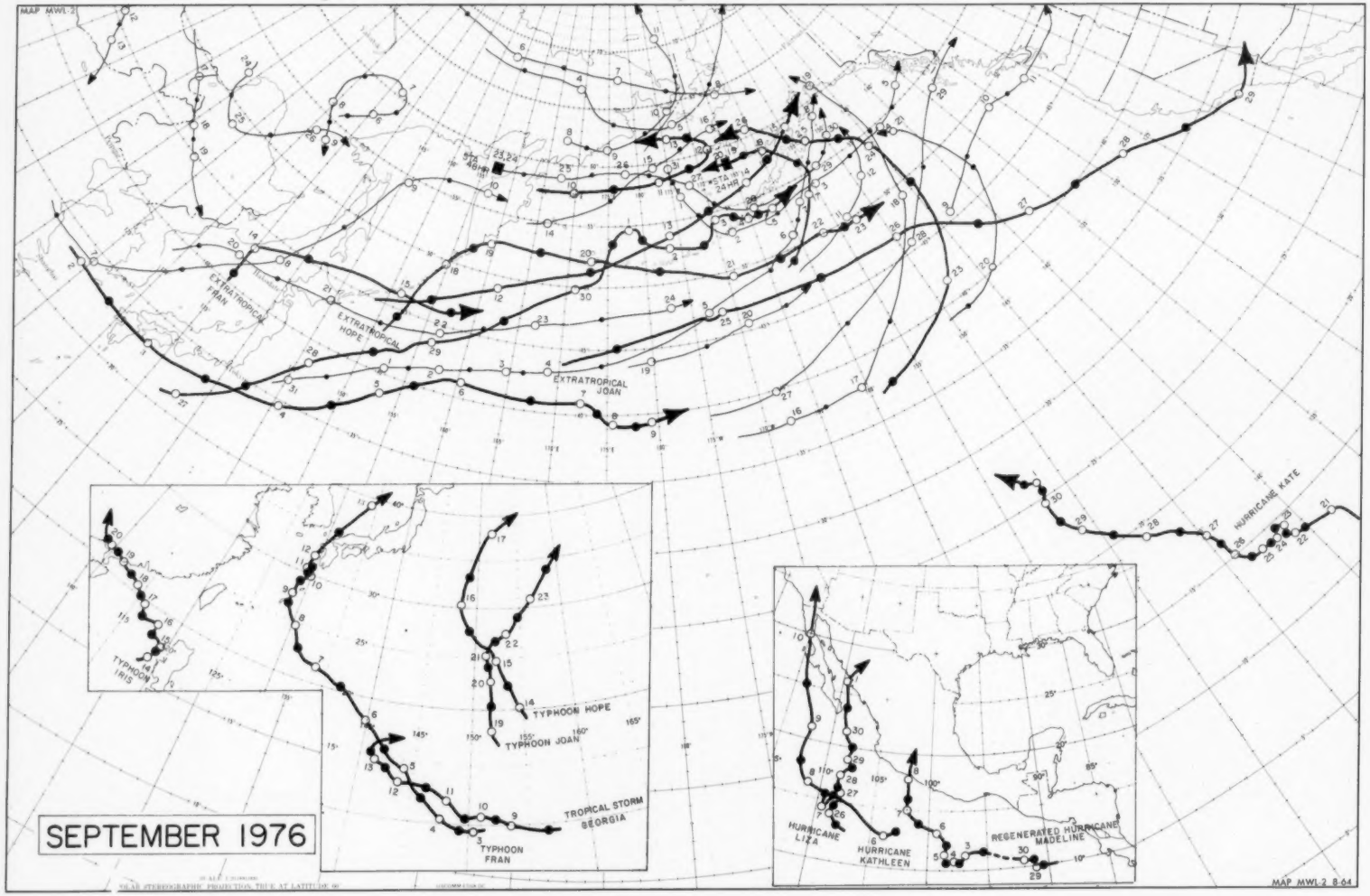

Figure 54. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

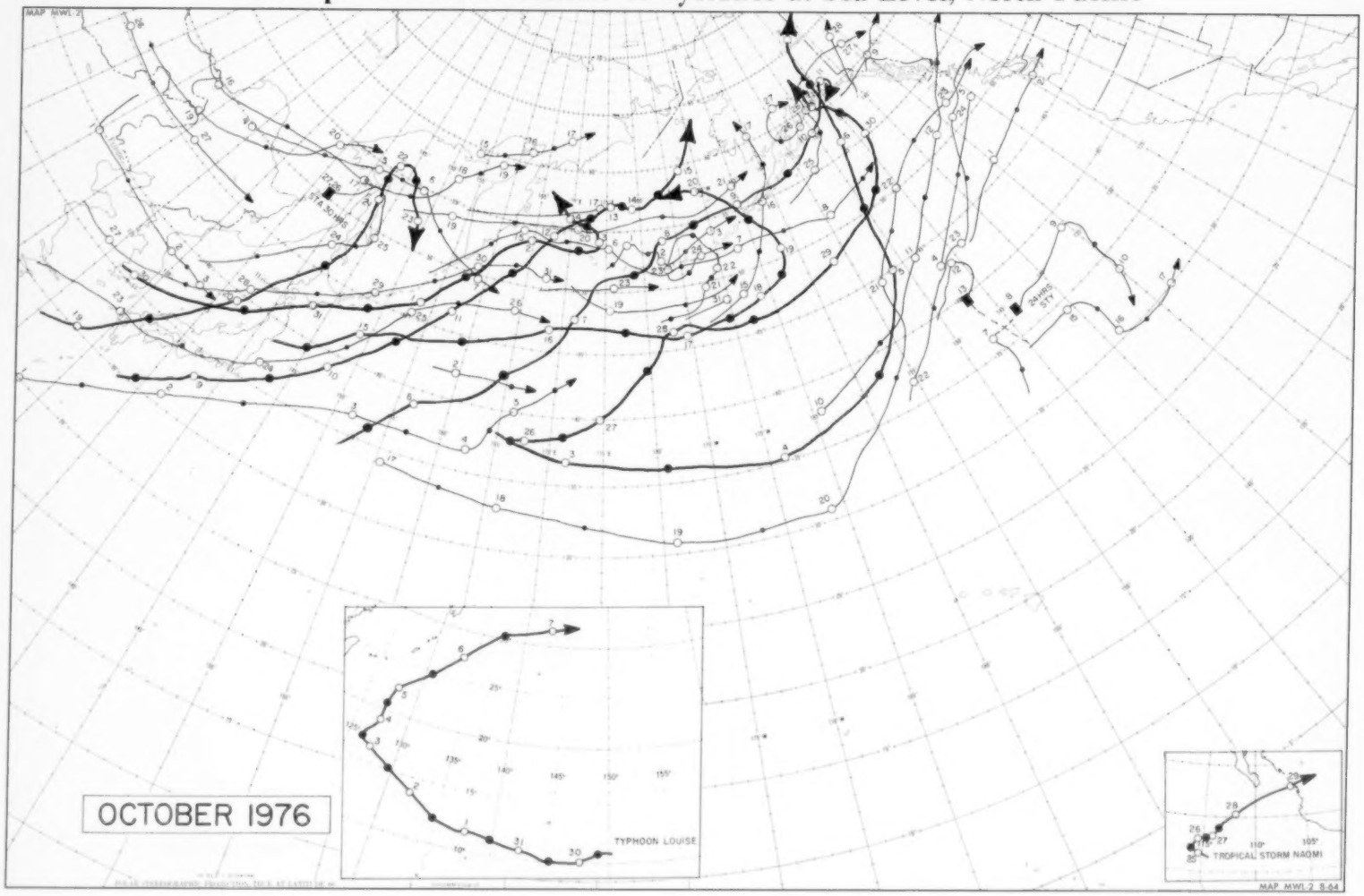

Figure 55. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 8
U. S. Ocean Weather Station Climatological Data, North Atlantic

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W **September and October, 1976**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
SEPT	18.5	*07 00	22.3	28.8	28 06	8.1	*23 18	17.1	23.5	28 06	22.8	27 06	24.1	26.7	09 00	- 5.8	23 09	- 1.8	2.4	27 18
OCT	9.0	29 03	18.3	28.7	09 21	- .1	28 03	12.7	22.8	10 00	18.0	29 00	21.9	26.1	16 18	-11.6	19 06	- 3.6	2.5	09 18

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
SEPT	1001.9	21 21	1017.7	1028.3	*13 18	35.4	25.0	22.5	17.1	69.6	20.4	6.3	3.8	13	13	0	0	0	0	0	0	30	6.3	240
OCT	1000.2	26 15	1017.4	1031.3	19 15	18.1	23.9	31.9	26.1	39.9	28.6	25.2	6.3	18	17	0	1	0	0	0	0	29	14.7	238

** VV-90-93 AND OR W-4 COMP OB DAYS-COMPLETE OB DAYS

Wind

SEPT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.4	[illegible]	4.1	.7	.0	.0	[illegible]	13.4
NE	.0	[illegible]	[illegible]	.0	.0	.0	5.1	11.4
E	.0	1.3	4.0	.0	.0	.0	5.2	12.1
SE	.4	[illegible]	[illegible]	.4	.0	.0	13.0	[illegible]
S	1.9	3.0	[illegible]	1.8	.0	.0	13.6	[illegible]
SW	.7	6.9	5.1	4.5	.0	.0	17.2	[illegible]
W	1.1	5.1	5.8	.4	.0	.0	[illegible]	13.4
NW	.8	3.4	[illegible]	.5	.0	.0	17.0	13.6
CALM	2.9	.0	.0	.0	.0	.0	[illegible]	.0
TOTAL	8.3	28.3	55.0	8.3	.0	.0	100.0	13.6

NUMBER OF OBS 240; MAX WIND DIR [illegible] SPEED [illegible] DA HR [illegible]; VECTOR SPEED 3.7; MEAN DIR 247 (DIR IN DEGREES)

OCT WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	3.0	7.7	5.8	1.2	.0	17.6	19.4
NE	.0	3.3	6.0	1.9	.4	.0	11.5	16.2
E	.0	4.0	1.7	.7	.0	.0	6.4	11.4
SE	.0	4.3	4.1	1.5	.2	.0	10.1	13.5
S	.4	2.5	4.3	2.6	1.9	.0	11.8	18.8
SW	.8	2.3	5.3	.9	.8	.0	10.2	15.0
W	.0	2.1	5.8	7.8	.4	.0	16.1	19.7
NW	.0	2.8	6.8	5.7	.1	.0	15.4	18.5
CALM	.8	.0	.0	.0	.0	.0	.8	.0
TOTAL	2.1	24.4	41.6	26.9	5.0	.0	100.0	17.2

NUMBER OF OBS 238; MAX WIND DIR [illegible] SPEED [illegible] DA HR 21 [illegible]; VECTOR SPEED 4.5; MEAN DIR 309 (DIR IN DEGREES)

Wave

SEPT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	1.4	7.8	2.5	.0	.0	.0	.0	.0	11.7
NE	.6	1.3	.0	.0	.0	.0	.0	.0	1.9
E	1.4	6.0	.0	.0	.0	.0	.0	.0	7.4
SE	1.5	10.3	1.7	.0	.0	.0	.0	.0	13.4
S	.0	7.5	2.5	1.1	.0	.0	.0	.0	11.1
SW	.8	3.4	4.5	2.2	.0	.0	.0	.0	10.9
W	.0	3.6	6.8	.4	.0	.0	.0	.0	10.8
NW	.6	8.3	5.8	1.3	.0	.0	.0	.0	16.0
IND	4.6	9.2	2.9	.0	.0	.0	.0	.0	16.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	10.8	57.5	26.7	5.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 240 IND-INDETERMINATE

OCT WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.7	4.5	2.8	5.5	1.6	.0	.0	.0	15.1
NE	.9	8.0	5.8	2.9	.5	.0	.0	.0	18.2
E	.7	3.0	3.0	.0	.0	.0	.0	.0	6.8
SE	.9	1.8	.6	.9	.4	.0	.0	.0	4.7
S	.4	4.0	5.4	2.4	1.7	.0	.0	.0	13.9
SW	.4	.8	.5	1.3	1.4	.0	.0	.0	4.4
W	.0	.7	6.2	4.7	1.2	.0	.0	.0	12.8
NW	1.3	2.3	5.5	5.4	.0	.0	.0	.0	14.4
IND	.0	6.3	2.9	.4	.0	.0	.0	.0	9.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	5.5	31.5	32.8	23.5	6.7	.0	.0	.0	100.0

NUMBER OF OBS 238 IND-INDETERMINATE

SEPT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	5.0	22.5	5.1	.0	.0	.0	.0	.0	32.5
6-7	.8	23.3	18.3	5.0	.0	.0	.0	.0	47.5
8-9	.4	2.5	.4	.0	.0	.0	.0	.0	3.3
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	4.6	9.2	2.9	.0	.0	.0	.0	.0	16.7
TOTAL	10.8	57.5	26.7	5.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 240; MAX WAVE HEIGHT: HGT 3.5, PER 7, DIR 190, TYPE SEA, DA HR 21 21; IND-INDETERMINATE (DIR IN DEGREES)

OCT WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	2.9	5.0	5.5	.0	.0	.0	.0	.0	13.4
6-7	2.5	19.7	23.9	18.5	2.5	.0	.0	.0	67.2
8-9	.0	.4	.4	4.2	3.4	.0	.0	.0	8.4
10-11	.0	.0	.0	.4	.4	.0	.0	.0	.8
12-13	.0	.0	.0	.0	.4	.0	.0	.0	.4
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	6.3	2.9	.4	.0	.0	.0	.0	9.7
TOTAL	5.5	31.5	32.8	23.5	6.7	.0	.0	.0	100.0

NUMBER OF OBS 238; MAX WAVE HEIGHT: HGT 5.5, PER 8, DIR 240, TYPE SEA, DA HR 21 09; IND-INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell group was selected for summarization: if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 9
U. S. Ocean Buoy Climatological Data
September and October 1976

SEPTEMBER DATA SUMMARY EB01
AVERAGE LATITUDE 35.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	19.6	(22 18)	24.0	26.1	(18 09)	162	22
SEA TEMP (DEG C)	24.6	(16 15)	25.6	26.8	(10 21)	160	22
AIR-SEA TEMP (DEG C)	-05.6	(22 18)	-01.5	00.5	(28 15)	160	22
PRESSURE (MBAR)	1003.9	(21 18)	1016.5	1027.8	(13 15)	162	22

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.6	3.1	9.9	.6			14.7	12.7
NE		5.6	4.3				9.9	10.4
E	1.9	8.0	8.8				18.7	9.8
SE	1.2	.6	6.8				8.6	13.2
S			13.0	1.2			14.2	15.6
SW	1.2	3.1	17.3	1.9			23.5	13.9
W	1.9	1.2	2.5				5.6	9.2
NW	.6	1.2	4.3	1.2			7.4	15.8
CALM								
TOTAL	7.4	22.8	64.8	4.9			100.0	12.7

NO. OF OBS: 162
MAX WIND SPEED: 27 KNOTS DIRECTION: 330 DEG DAY: 11 HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	14.5	36.4	8.1						1.1M	2.5M (22 00)

NO. OF WAVE OBS: 161

OCTOBER DATA SUMMARY EB01
AVERAGE LATITUDE 35.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.8	(29 00)	21.2	26.8	(05 21)	249	31
SEA TEMP (DEG C)	23.2	(31 21)	24.8	26.1	(06 21)	249	31
AIR-SEA TEMP (DEG C)	-10.1	(28 09)	-03.6	00.8	(09 21)	249	31
PRESSURE (MBAR)	1001.9	(26 18)	1018.6	1027.7	(23 15)	249	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.6	2.5	8.7	8.6			21.0	10.6
NE		2.1	2.5	2.5			7.0	13.9
E	1.2	2.9	2.5				5.9	8.6
SE	.4	2.1	2.9	.8			6.2	14.0
S	.8	2.5	12.3	6.6	.8		23.0	19.0
SW	.4	2.5	4.1	2.9			9.9	10.0
W	.4	2.9	5.8	2.9			11.9	13.5
NW		2.5	10.3	1.2			14.0	14.9
CALM	1.6						1.6	.0
TOTAL	6.6	19.0	47.3	25.5	.8		100.0	12.2

NO. OF OBS: 248
MAX WIND SPEED: 97 KNOTS DIRECTION: 200 DEG DAY: 21 HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	.8	52.3	26.6	18.1	2.1				1.0M	4.0M (21 06)

NO. OF WAVE OBS: 237

SEPTEMBER DATA SUMMARY EB03
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.3	(20 03)	09.4	11.4	(13 18)	240	30
SEA TEMP (DEG C)	07.9	(30 12)	09.8	11.8	(01 03)	240	30
AIR-SEA TEMP (DEG C)	-03.2	(20 03)	-00.4	01.9	(24 12)	240	30
PRESSURE (MBAR)	0977.0	(24 15)	1002.8	1023.2	(10 09)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		2.1	.4	.4			3.3	13.5
NE	.4		.4	.4	.4		1.7	20.8
E	.8	1.7	7.9	5.4	.8		16.3	20.5
SE		3.3	9.4	5.0	2.5		16.3	20.9
S	.4	4.2	11.7	9.2			25.4	18.2
SW		2.5	7.9	7.9	.4		18.8	18.9
W		4.2	5.8	2.1			12.1	14.4
NW			5.4	.4			5.8	13.9
CALM	.4						.4	.0
TOTAL	1.7	17.9	48.0	31.3	4.2		100.0	18.4

NO. OF OBS: 240
MAX WIND SPEED: 41 KNOTS DIRECTION: 110 DEG DAY: 24 HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	9.8	20.8	32.9	20.7	13.1	3.4			2.0M	7.5M (18 06)

NO. OF WAVE OBS: 237

OCTOBER DATA SUMMARY EB03
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.0	(28 03)	08.5	10.2	(02 21)	221	28
SEA TEMP (DEG C)	06.8	(28 03)	07.9	08.2	(02 21)	221	28
AIR-SEA TEMP (DEG C)	-00.8	(27 09)	-00.9	00.8	(20 12)	219	28
PRESSURE (MBAR)	0979.2	(06 12)	1008.7	1027.7	(19 21)	221	28

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.9	.9				1.8	10.8
NE		3.7					3.7	7.0
E		9.6	9.6	.9	.9		12.8	14.1
SE	.9	.9	9.2	4.1			15.1	17.7
S		4.1	15.1	6.4			25.6	16.8
SW	.5	3.2	14.2	2.3			20.1	16.0
W	.9	3.7	7.8	3.7			16.1	15.1
NW		1.4	5.2	.9			9.0	14.0
CALM	1.4						1.4	.0
TOTAL	3.8	23.3	34.0	17.8	.9		100.0	15.8

NO. OF OBS: 219
MAX WIND SPEED: 97 KNOTS DIRECTION: 070 DEG DAY: 06 HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		27.6	45.7	20.4	5.0	1.4			1.3M	6.0M (09 12)

NO. OF WAVE OBS: 221

SEPTEMBER DATA SUMMARY EB15
AVERAGE LATITUDE 32.3N AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.8	(22 09)	24.9	27.9	(03 15)	238	30
SEA TEMP (DEG C)	25.7	(23 13)	26.4	28.2	(30 06)	239	30
AIR-SEA TEMP (DEG C)	-05.7	(29 06)	-01.7	01.1	(08 15)	238	30
PRESSURE (MBAR)	1008.3	(21 21)	1016.9	1028.2	(13 15)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	.8	2.5				3.8	11.8
NE	.4	2.9	6.3				9.2	11.8
E	.8	10.0	13.4	.8			24.7	12.9
SE	.8	2.9	2.1	1.7			7.5	12.6
S	1.7	7.5	13.0	.8			23.0	11.8
SW		4.6	8.4	.8			13.8	13.2
W	1.3	2.9	5.4	.8			10.5	11.6
NW	1.3	4.2	1.7				7.1	8.7
CALM	.4						.4	.0
TOTAL	6.7	35.6	52.7	5.0			100.0	11.8

NO. OF OBS: 239
MAX WIND SPEED: 96 KNOTS DIRECTION: 130 DEG DAY: 19 HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	54.9	43.4	1.8						.8M	2.0M (30 21)

NO. OF WAVE OBS: 113

OCTOBER DATA SUMMARY EB15
AVERAGE LATITUDE 32.3N AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	16.9	(29 06)	22.3	26.4	(09 15)	245	31
SEA TEMP (DEG C)	24.4	(31 18)	26.0	27.9	(01 06)	245	31
AIR-SEA TEMP (DEG C)	-08.4	(29 00)	-03.6	00.3	(21 00)	245	31
PRESSURE (MBAR)	1004.4	(26 09)	1016.0	1027.8	(23 15)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	3.7	11.4	6.9			22.4	17.1
NE	1.6	4.5	9.7	5.3			17.1	14.0
E	.8	3.3	6.1	1.6			11.9	13.1
SE		2.0	4.1	2.4			8.3	14.8
S	.8	1.2	8.2	5.3			15.5	17.7
SW		.8	4.9	1.2			6.9	10.2
W		3.3	8.2	1.2			12.7	14.8
NW		2.4	9.7				12.1	12.7
CALM								
TOTAL	4.1	21.2	82.7	23.4			100.0	15.5

NO. OF OBS: 245
MAX WIND SPEED: 93 KNOTS DIRECTION: 180 DEG DAY: 20 HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	16.7	45.7	30.6	6.9					1.1M	3.3M (28 18)

NO. OF WAVE OBS: 245

SEPTEMBER DATA SUMMARY EB16
AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	14.8	(02 09)	15.9	16.9	(09 00)	43	7
SEA TEMP (DEG C)	17.0	(09 15)	17.3	18.1	(01 00)	43	7
AIR-SEA TEMP (DEG C)	-02.4	(01 00)	-01.3	-00.4	(09 00)	43	7
PRESSURE (MBAR)	1015.8	(05 12)	1021.7	1029.4	(07 18)	43	7

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.3	2.3	34.9				39.5	14.0
NE								
E								
SE								
S								
SW			7.0				7.0	13.0
W		7.0	14.0				20.9	12.0
NW	2.3	7.0	23.3				32.6	14.8
CALM								
TOTAL	4.7	16.3	79.1				100.0	13.7

NO. OF OBS: 43
MAX WIND SPEED: 21 KNOTS DIRECTION: 330 DEG DAY: 02 HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		94.9	5.1						1.3M	2.5M (02 09)

NO. OF WAVE OBS: 39

OCTOBER DATA SUMMARY EB16
AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.9	(28 12)	15.0	16.8	(11 21)	206	26
SEA TEMP (DEG C)	15.5	(31 18)	16.3	17.1	(12 03)	206	26
AIR-SEA TEMP (DEG C)	-03.5	(14 21)	-01.5	00.2	(24 09)	206	26
PRESSURE (MBAR)	1008.5	(08 00)	1019.4	1030.2	(25 21)	206	26

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.0	7.3	15.8	1.0			24.3	12.9
NE		9.6	13.6				23.8	14.3
E		1.5	2.9				4.4	11.7
SE								
S	.5	1.5	9.7	1.9			13.6	15.6
SW	.5	2.4	11.7	1.5			15.9	15.2
W	1.0	3.9	1.9	2.9			9.7	14.2
NW		3.4	5.3	1.0			9.7	12.8
CALM								
TOTAL	2.9	29.3	64.5	8.3			100.0	14.0

NO. OF OBS: 206
MAX WIND SPEED: 93 KNOTS DIRECTION: 260 DEG DAY: 24 HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS)

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		45.4	42.9	5.9	5.9				2.0M	5.0M (25 09)

NO. OF WAVE OBS: 205

SEPTEMBER D A T A S U M M A R Y EB17

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.0	(17 15)	08.4	10.8	(07 00)	240	30
SEA TEMP (DEG C)	07.5	(22 12)	08.9	10.5	(05 21)	239	30
AIR-SEA TEMP (DEG C)	-02.7	(17 15)	-00.5	00.7	(25 09)	239	30
PRESSURE (MBAR)	0974.3	(17 15)	1002.2	1019.7	(10 06)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.3					1.7	9.6
NE		.4					.4	10.0
E		.8	7.1	1.7			9.6	18.4
SE		1.7	2.9		.4		5.0	13.5
S		9.8	4.2	3.4	.4	.4	16.7	19.2
SW		3.8	12.9	9.6	3.3	.4	30.0	21.2
W		3.8	19.6	6.3			31.7	17.8
NW		.8	5.0	.8	.4		7.1	17.7
CALM	.4						.4	.0
TOTAL	.8	16.3	51.7	25.8	4.6	.8	100.0	18.6

NO. OF OBS: 240
MAX WIND SPEED: 94 KNOTS DIRECTION: 240 DEG DAY: 17 HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	2.1	27.1	30.3	18.3	17.5	3.8			2.6M	7.5M	(15 09)

OCTOBER D A T A S U M M A R Y EB17

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.7	(31 21)	06.1	08.2	(21 06)	245	31
SEA TEMP (DEG C)	06.4	(31 21)	07.9	07.9	(07 03)	245	31
AIR-SEA TEMP (DEG C)	-07.5	(27 15)	-01.8	01.0	(21 06)	245	31
PRESSURE (MBAR)	0988.2	(31 10)	1004.7	1028.2	(19 06)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.4	1.8	2.4	.4		4.9	22.5
NE		.4	1.2	.4	.4		2.4	17.0
E		1.6	2.4	2.9			6.9	18.9
SE	.4	1.6	7.3	4.5	.8		14.7	19.9
S	.4	.8	19.1	6.1			27.4	18.1
SW		1.6	10.6	6.9			19.2	18.2
W		1.2	9.8	9.8			20.8	20.4
NW			3.3	4.9	.4		8.6	18.7
CALM							.0	
TOTAL	.8	7.8	51.4	38.0	2.0		100.0	19.9

NO. OF OBS: 245
MAX WIND SPEED: 97 KNOTS DIRECTION: 120 DEG DAY: 16 HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 244

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		7.8	39.8	39.8	12.7				2.9M	5.0M	(30 21)

SEPTEMBER D A T A S U M M A R Y EB19

AVERAGE LATITUDE 51.0N AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.0	(23 09)	11.9	13.7	(24 00)	238	30
SEA TEMP (DEG C)	11.2	(25 08)	12.5	13.4	(02 00)	238	30
AIR-SEA TEMP (DEG C)	-02.7	(07 00)	-00.6	01.3	(24 20)	238	30
PRESSURE (MBAR)	0989.9	(27 18)	1013.8	1027.5	(08 18)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.7	6.8				8.4	13.7
NE	.4	.4	.8				1.7	8.0
E	.8		3.0	.8			4.7	14.1
SE		2.8	9.9	3.0			14.4	17.2
S		5.5	12.3	9.7			27.4	18.1
SW	.4	2.1	8.9	4.7			16.1	17.4
W		3.4	11.0	3.4	.4		18.2	16.8
NW		3.9	2.1	.8			6.8	16.8
CALM							.0	
TOTAL	1.7	21.6	53.8	22.5	.4		100.0	16.1

NO. OF OBS: 236
MAX WIND SPEED: 36 KNOTS DIRECTION: 260 DEG DAY: 30 HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	3.0	24.8	47.0	18.6	6.8				2.3M	5.5M	(14 09)

OCTOBER D A T A S U M M A R Y EB19

AVERAGE LATITUDE 51.0N AVERAGE LONGITUDE 136.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.7	(31 12)	10.2	12.8	(06 09)	246	31
SEA TEMP (DEG C)	10.1	(31 21)	11.2	11.9	(01 21)	245	31
AIR-SEA TEMP (DEG C)	-05.5	(31 12)	-01.0	01.7	(26 15)	245	31
PRESSURE (MBAR)	0980.6	(30 09)	1016.0	1032.3	(14 00)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		5.7	4.1	.4			10.2	11.5
NE		5.3	2.4				9.7	10.1
E		2.4	2.0				4.5	10.3
SE	.4	2.8	9.1	1.2			13.6	12.7
S		6.9	7.9	7.3	2.0		23.6	17.5
SW		2.6	11.0	5.3	2.0		20.7	19.5
W	.8	2.4	5.7	4.1			13.0	16.5
NW	.8	3.3	3.7	2.4	1.2		11.4	16.2
CALM	.4						.4	.0
TOTAL	2.4	29.3	42.3	20.7	5.3		100.0	15.7

NO. OF OBS: 246
MAX WIND SPEED: 40 KNOTS DIRECTION: 160 DEG DAY: 30 HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 246

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		30.2	33.7	20.3	6.5	2.4	.8		2.4M	8.0M	(31 00)

SEPTEMBER D A T A S U M M A R Y EB21

AVERAGE LATITUDE 46.0N AVERAGE LONGITUDE 131.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.1	(23 09)	14.9	16.8	(27 00)	151	20
SEA TEMP (DEG C)	15.2	(22 12)	15.5	16.2	(19 03)	152	20
AIR-SEA TEMP (DEG C)	-05.3	(23 09)	-00.6	01.1	(27 00)	151	20
PRESSURE (MBAR)	0941.9	(27 09)	1016.4	1029.1	(15 06)	152	20

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.7	8.6	9.2				18.4	10.0
NE	1.3	8.6					9.9	6.3
E	2.0	.7					2.6	2.8
SE			9.2	5.3	.7		15.1	15.0
S		1.3	13.8	5.3			20.4	18.0
SW	.7	1.3	3.3				5.3	11.3
W	.7	3.3	5.9				9.9	11.9
NW	.7	7.2	8.6				16.4	10.5
CALM	2.0						2.0	.0
TOTAL	7.9	30.9	50.0	10.5	.7		100.0	12.0

NO. OF OBS: 152
MAX WIND SPEED: 34 KNOTS DIRECTION: 140 DEG DAY: 27 HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 151

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		32.5	43.0	21.9	2.6				2.2M	4.5M	(27 12)

OCTOBER D A T A S U M M A R Y EB21

AVERAGE LATITUDE 46.0N AVERAGE LONGITUDE 131.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.8	(24 21)	13.7	15.7	(10 00)	249	31
SEA TEMP (DEG C)	14.0	(31 18)	14.7	15.6	(01 00)	248	31
AIR-SEA TEMP (DEG C)	-03.7	(24 21)	-01.0	00.9	(27 09)	243	31
PRESSURE (MBAR)	1004.0	(24 12)	1020.0	1028.1	(09 21)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.7	7.7				11.4	12.8
NE		1.6	16.7	.4			18.7	13.0
E		2.0	9.3				9.3	11.9
SE		1.6	5.2				7.4	9.0
S		2.0	9.3	6.5			17.9	19.2
SW	.8	4.9	7.7	.8			14.7	12.1
W		4.5	8.5	3.3	.8		18.1	15.3
NW	.4	2.4	4.9	2.4	.4		10.6	16.2
CALM								
TOTAL	1.7	26.8	89.3	13.4	1.2		100.0	13.0

NO. OF OBS: 248
MAX WIND SPEED: 95 KNOTS DIRECTION: 290 DEG DAY: 29 HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 245

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		42.4	37.1	11.0	9.0	.4			2.2M	6.0M	(31 06)

SEPTEMBER D A T A S U M M A R Y EB35

AVERAGE LATITUDE 55.2N AVERAGE LONGITUDE 150.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	06.1	(27 09)	08.7	10.7	(04 06)	229	30
SEA TEMP (DEG C)	08.5	(27 15)	09.4	11.0	(06 18)	229	30
AIR-SEA TEMP (DEG C)	-03.1	(29 09)	-00.7	01.0	(09 21)	224	30
PRESSURE (MBAR)	0976.6	(17 21)	0999.6	1020.9	(10 00)	227	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.3	2.2	.4			4.5	12.1
NE	.4	1.3	9.0	.9			11.6	13.8
E		3.4	6.5	.9			10.7	11.7
SE	.9	3.4	9.4				13.8	10.6
S	.4	4.0	10.3	2.2			17.0	14.8
SW	.4	4.9	10.7	1.8			17.8	13.6
W	1.8	6.7	7.6	1.8			17.9	11.6
NW		4.5	8.0	1.8			14.3	14.4
CALM								
TOTAL	4.5	39.5	92.2	9.8			100.0	12.9

NO. OF OBS: 224
MAX WIND SPEED: 97 KNOTS DIRECTION: 220 DEG DAY: 15 HOUR: 03

OCTOBER D A T A S U M M A R Y EB35

AVERAGE LATITUDE 55.2N AVERAGE LONGITUDE 150.7W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	+05.0	(28 21)	05.8	08.8	(08 21)	240	31
SEA TEMP (DEG C)	06.4	(28 18)	08.4	09.4	(07 00)	240	31
AIR-SEA TEMP (DEG C)	-10.7	(28 21)	-02.6	00.0	(02 15)	240	31
PRESSURE (MBAR)	0983.9	(31 15)	1003.7	1028.1	(12 21)	240	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4=	11-	22-	34=	47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.4	6.3	1.7			8.3	18.2
NE		.8	1.3	.4			2.5	13.9
E	.4	2.1	7.5	2.5			12.4	16.9
SE		1.3	17.1	2.5			20.8	18.2
S		2.5	13.8	2.1			18.4	16.2
SW		1.7	9.2				10.8	14.2
W		2.5	9.2	1.3			12.9	14.9
NW		.4	11.3	2.1			13.8	17.2
CALM								
TOTAL	.4	11.7	79.4	12.5			100.0	16.1

NO. OF OBS: 240
MAX WIND SPEED: 90 KNOTS DIRECTION: 100 DEG DAY: 16 HOUR: 06

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING - MODERATE: 2.5% SEVERE: NONE #OBS: 240

SEPTEMBER D A T A S U M M A R Y 8843

AVERAGE LATITUDE 59.7N AVERAGE LONGITUDE 141.8W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.5	(04 00)	10.7	12.8	(09 21)	92	6
SEA TEMP (DEG C)	12.0	(05 18)	12.8	13.2	(07 09)	92	6
AIR-SEA TEMP (DEG C)	-04.0	(04 00)	-02.1	00.3	(09 21)	92	6
PRESSURE (MBAR)	1000.3	(03 12)	1008.6	1021.0	(01 00)	92	6

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N								
NE	3.1	6.3	40.6	19.8			69.8	19.2
E		12.5	3.1				15.6	9.8
SE								
S								
SW	3.1	3.1					6.3	4.8
W	9.1	9.4					12.5	7.5
NW								
CALM								
TOTAL	9.4	31.3	43.8	15.6			100.0	12.8

NO. OF OBS: 32

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 040 DEG
DAY: 03
HOUR: 15

OCTOBER D A T A S U M M A R Y 8843

AVERAGE LATITUDE 59.8N AVERAGE LONGITUDE 142.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.4	(17 03)	07.0	09.1	(21 03)	82	18
SEA TEMP (DEG C)	09.3	(16 21)	09.9	10.4	(19 21)	82	18
AIR-SEA TEMP (DEG C)	-04.7	(14 15)	-02.9	-00.8	(21 06)	82	18
PRESSURE (MBAR)	1001.0	(29 03)	1020.4	1028.2	(14 09)	81	18

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.9	1.9					3.9	4.1
NE	3.8	1.9					5.8	3.5
E	3.9	18.8	22.6	19.0			64.3	16.1
SE		9.0	10.9				19.9	12.3
S	2.5						2.5	1.8
SW	1.9						1.9	3.0
W	5.0	6.3					11.3	6.9
NW	1.9	3.8	1.9				6.9	6.0
CALM								
TOTAL	17.9	39.8	35.8	19.0			100.0	12.2

NO. OF OBS: 80

MAX WIND
SPEED: 33 KNOTS
DIRECTION: 090 DEG
DAY: 17
HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 78

HEIGHT (M)	<1	1-1.9	2-2.9	3-3.5	4-5.5	6-7.5	8-9.9	>9.9	MEAN	MAX	(DA HR)
% FREQUENCY	5.9	56.0	30.7	6.0					1.7M	3.5M	(17 18)

SEPTEMBER D A T A S U M M A R Y 8861

AVERAGE LATITUDE 28.9N AVERAGE LONGITUDE 090.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.2	(30 12)	26.8	30.5	(25 21)	70	12
PRESSURE (MBAR)	1009.0	(28 00)	1012.8	1017.8	(30 15)	70	12

OCTOBER D A T A S U M M A R Y 8861

AVERAGE LATITUDE 28.8N AVERAGE LONGITUDE 090.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.9	(31 12)	20.7	28.7	(09 18)	233	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.2	3.0	13.4	3.4			25.0	14.3
NE	.9	3.4	18.9	3.9			26.7	13.3
E	.4	4.3	10.9	3.0			18.5	14.0
SE	.9	3.4	6.0	1.7			12.1	14.8
S	.9	1.3	5.2	.4	.4		8.2	13.6
SW		.4	.4				.9	13.0
W	.9	2.2	.9	.4			4.3	9.2
NW	.4		3.4				3.9	10.1
CALM	.4						.4	.0
TOTAL	6.9	21.1	58.6	12.9	.4		100.0	14.3

NO. OF OBS: 232

MAX WIND
SPEED: 34 KNOTS
DIRECTION: 180 DEG
DAY: 30
HOUR: 03

SEPTEMBER D A T A S U M M A R Y 8870

AVERAGE LATITUDE 59.5N AVERAGE LONGITUDE 142.3W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.0	(30 12)	10.8	14.0	(21 21)	208	30
SEA TEMP (DEG C)	09.9	(22 15)	11.3	12.7	(01 03)	205	30
AIR-SEA TEMP (DEG C)	-02.5	(30 12)	-00.5	02.8	(21 21)	205	30
PRESSURE (MBAR)	0981.7	(28 09)	1008.4	1020.3	(10 15)	207	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		.5					.5	7.0
NE	.9	1.0	1.0				2.4	9.6
E	.9	6.8	25.6	9.7			42.9	19.7
SE	1.4	4.2	10.9	.5			27.1	11.9
S	1.0	9.2	7.2				17.4	9.8
SW	1.0	.5	1.4				2.9	7.7
W	1.0	3.9	.5				5.9	7.9
NW		1.4					1.4	7.7
CALM	.5						.5	.0
TOTAL	5.8	31.4	52.7	10.1			100.0	12.8

NO. OF OBS: 207

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 080 DEG
DAY: 13
HOUR: 06

OCTOBER D A T A S U M M A R Y 8870

AVERAGE LATITUDE 59.5N AVERAGE LONGITUDE 142.4W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.7	(28 18)	07.5	10.1	(07 12)	237	31
SEA TEMP (DEG C)	08.6	(30 15)	09.8	10.8	(02 03)	237	31
AIR-SEA TEMP (DEG C)	-09.9	(28 18)	-02.3	-00.2	(21 00)	237	31
PRESSURE (MBAR)	0983.9	(31 06)	1007.9	1027.8	(14 00)	237	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.7					1.7	6.0
NE	.4	1.3	.9				2.6	7.3
E	.9	9.4	10.2	10.9	2.6		33.9	21.6
SE	.4	5.4	9.1	3.0	.9		18.8	17.0
S	.9	4.7	10.6	3.8	.4		20.4	15.8
SW	.4	2.6	4.3	1.3			8.3	13.5
W	.4	8.4	9.4	1.3			19.4	13.2
NW	.4	3.0	.9	.4			4.7	10.6
CALM								
TOTAL	3.8	28.4	45.3	24.7	3.8		100.0	16.9

NO. OF OBS: 235

MAX WIND
SPEED: 42 KNOTS
DIRECTION: 080 DEG
DAY: 21
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 209

HEIGHT (M)	<1	1-1.9	2-2.9	3-3.5	4-5.5	6-7.5	8-9.9	>9.9	MEAN	MAX	(DA HR)
% FREQUENCY		32.5	34.0	20.2	8.6	4.8	1.0		2.6M	8.5M	(31 06)

SEPTEMBER D A T A S U M M A R Y 8871

AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 093.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.0	(21 15)	27.3	28.7	(25 18)	90	12
SEA TEMP (DEG C)	28.2	(29 12)	28.7	30.9	(25 21)	90	12
AIR-SEA TEMP (DEG C)	-05.4	(21 15)	-01.5	-00.2	(28 03)	90	12
PRESSURE (MBAR)	1007.5	(21 21)	1012.2	1016.3	(24 18)	90	12

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	8.9	12.8					21.9	4.6
NE		2.1	10.6				12.8	13.2
E	2.1						2.1	3.1
SE	2.1	4.3	4.3				10.6	8.0
S	4.3	19.1	14.9				38.3	9.3
SW	2.1						2.1	1.0
W	4.3						4.3	2.0
NW	2.1	2.1					4.3	4.0
CALM	4.3						4.3	.0
TOTAL	29.8	40.4	29.8				100.0	7.4

NO. OF OBS: 47

MAX WIND
SPEED: 17 KNOTS
DIRECTION: 090 DEG
DAY: 03
HOUR: 03

OCTOBER D A T A S U M M A R Y 8871

AVERAGE LATITUDE 29.0N AVERAGE LONGITUDE 093.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.2	(26 21)	23.5	27.4	(05 12)	232	31
SEA TEMP (DEG C)	24.3	(31 03)	26.5	28.0	(02 21)	232	31
AIR-SEA TEMP (DEG C)	-07.3	(20 21)	-02.8	00.7	(29 18)	232	31
PRESSURE (MBAR)	1009.2	(05 21)	1016.4	1024.6	(21 15)	232	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)								
DIR	<4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	9.1	18.1	5.2			32.8	10.7
NE	.4	10.3	5.2	1.3			17.2	10.9
E		10.8	11.6	3.0			25.4	12.7
SE	.9	6.7	9.9	1.3			18.8	12.4
S	.4	1.7	.4				2.6	7.6
SW	.4						.9	3.0
W	.4	.4					.9	3.5
NW		3.2	1.7				5.9	12.0
CALM								
TOTAL	3.0	39.2	47.0	10.8			100.0	12.7

NO. OF OBS: 232

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 350 DEG
DAY: 29
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 212

HEIGHT (M)	<1	1-1.9	2-2.9	3-3.5	4-5.5	6-7.5	8-9.9	>9.9	MEAN	MAX	(DA HR)
% FREQUENCY	24.5	33.5	14.2	8.0					1.8M	3.5M	(29 21)

(Continued on page 122.)

Table 10
Selected Gale and Wave Observations, North Atlantic
September and October 1976

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC OCEAN		SEP.															
PROVIDENCE MULTINA	FRENCH	1	32.3 N	38.2 W	12	28	M 46 (E)	2 NM	02	1003.9	27.5	25.1			28	10	23
LEON	HONDURAN	1	30.5 N	35.4 W	21	30	60 (E)	2 NM	62	1005.8	25.5	26.0	5	28	XX	X	46
LEON	HONDURAN	2	30.6 N	35.3 W	00	30	60 (E)	1 NM	62	1005.1	25.5	26.0	5	28	XX	X	46
AMOCO BRISBANE	LIBERIAN	4	34.9 N	31.6 W	18	18	48 (F)	2 NM	18	1000.0	22.0	24.0			18	9	18
AMOCO BRISBANE	LIBERIAN	5	35.3 N	30.0 W	00	18	48 (F)	2 NM	18	1008.1	22.0	24.0			20	9	19.5
SEALIFT INDIAN OCEAN	AMERICAN	5	39.1 N	25.9 W	12	23	45	5 NM	60	1007.5	22.5	21.2	2	5	23	7	14.5
SEATTLE	AMERICAN	7	42.2 N	53.7 W	18	20	45	2 NM	21	1006.7	21.7	22.8	6	6.5	20	9	14.5
ANTE TOPIC	LIBERIAN	9	34.5 N	26.7 W	18	29	44	5 NM	64	1015.0	26.0	24.0	XX	13			
ANTE TOPIC	LIBERIAN	10	34.6 N	25.0 W	00	29	44	2 NM	62	1017.0	21.0	24.0	XX	13			
AMER ACCORD	AMERICAN	16	48.5 N	42.6 W	18	25	41	5 NM	02	1009.5	12.2	17.7	2	3	29	6	10
AMER LEGEND	AMERICAN	23	47.2 N	18.0 W	21	29	M 42	2 NM	25	978.9	14.5	16.7	6	14.5	29	11	18
GREEN HARBOUR	AMERICAN	24	46.0 N	24.7 W	18	34	M 40	10 NM	02	1000.0	16.3	16.8			34	>13	32.5
AMER LEGEND	AMERICAN	24	47.5 N	19.1 W	06	34	M 43	2 NM	25	974.3	15.6	16.7			34	12	19.5
GREEN HARBOUR	AMERICAN	25	45.8 N	24.2 W	06	35	M 40	10 NM	02	998.3	15.7	16.7			34	>13	32.5
AMER LEGEND	AMERICAN	25	47.3 N	25.3 W	00	02	M 42	5 NM	01	1000.4	14.5	16.7	6	11.5	02	11	18
AMER LEGEND	AMERICAN	28	42.7 N	59.3 W	12	25	M 42	5 NM	25	998.3	21.7	22.2	8	13	28	12	14.5
SEALAND RESOURCE	AMERICAN	29	47.9 N	46.4 W	18	28	42	5 NM	02	1005.0	9.4	8.9	5	8	27	< 6	11.5
AMER ALLIANCE	AMERICAN	29	49.3 N	40.7 W	12	20	45	.5 NM	63	990.0	17.2	13.4	9	21			
PVT JOHN R TOWLE	AMERICAN	29	53.3 N	35.7 W	18	17	45	.25 NM	60	992.6	12.3	11.1	6	8	17	6	11.5
GREAT LAKES VESSELS																	
G M HUMPHREY	AMERICAN	3	47.2 N	89.9 W	12	20	M 44	5 NM	18		18.0	16.0	6	6.5			
WILLIS B BOYER	AMERICAN	5	44.8 N	83.1 W	06	29	M 42	10 NM	21		12.0	16.0	3	13			
J L MAUTHE	AMERICAN	11	42.2 N	81.8 W	12	29	M 43	> 25 NM	02		18.0	21.0	5	10			
J L MAUTHE	AMERICAN	21	47.2 N	86.7 W	12	36	M 46	10 NM	13		8.0	12.0	5	11.5			
JOHN SHERWIN	AMERICAN	22	45.8 N	85.3 W	00	34	M 42	10 NM	02		8.0	14.0	5	10			
JOHN DYKSTRA	AMERICAN	23	45.1 N	83.2 W	18	27	M 46	> 25 NM	02		11.0	14.0	5	10			
CHARLES M BEEGHLY	AMERICAN	23	47.4 N	87.3 W	12	30	M 43	10 NM	02		2.0	9.0	6	13			
NORTH ATLANTIC OCEAN		OCT.															
COMET	AMERICAN	5	49.3 N	06.1 W	12	20	50	2 NM	02	1000.3	15.0	16.7	7	8	20	11	14.5
EXPORT LEADER	AMERICAN	7	40.7 N	61.6 W	00	15	45	5 NM	15	1004.4	22.5	24.5	6	11.5			
ATLANTIC CARRIER	LIBERIAN	7	48.9 N	10.4 W	00	20	47	5 NM	03	1001.0	15.0	15.0	6	11.5	20	7	16.5
DOCTOR LYKES	AMERICAN	8	26.2 N	87.7 W	22	33	M 45	.5 NM	62	1008.0	24.0	28.3	6	10			
MORMACLYNX	AMERICAN	10	37.6 N	69.7 W	00	20	45	5 NM	03	1004.5	26.0	26.8	5	14.5	20	10	19.5
AMER LEGACY	AMERICAN	11	48.3 N	14.2 W	12	32	50	5 NM	15	994.8	12.3	15.6			33	7	19.5
SEALAND ECONOMY	AMERICAN	11	47.6 N	10.2 W	12	30	50	10 NM	01	988.0	10.7	15.6			30	< 6	16.5
SEALAND ECONOMY	AMERICAN	12	45.2 N	16.0 W	06	27	45	5 NM	60	994.2	13.6	15.6	9	10	32	>13	16.5
ATLANTIC CARRIER	LIBERIAN	14	33.0 N	52.5 W	15	18	48	5 NM	01	1000.0	25.5	23.5	8	11.5	18	8	19.5
SUSQUEHANNA	AMERICAN	14	46.8 N	03.0 W	12	27	40	5 NM	01	999.7	14.4	20.6	2	14.5	27	13	42.5
AMER LEGACY	AMERICAN	15	44.8 N	49.4 W	06	27	47	10 NM	02	993.5	12.7	8.8					
SEALAND ECONOMY	AMERICAN	15	40.1 N	43.9 W	00	15	45	5 NM	03	1006.2	22.2	21.7	4	10	16	>13	19.5
SUSQUEHANNA	AMERICAN	15	46.9 N	03.6 W	00	27	35	5 NM	18	1007.8	12.8	17.8			27	X	41
AMER ACCORD	AMERICAN	16	49.1 N	30.2 W	12	27	41	5 NM	02	1001.5	12.2	13.9	4	11.5	27	10	13
AMER LEGACY	AMERICAN	16	43.4 N	58.5 W	06	27	47	10 NM	02	1010.0	10.2	10.2	6	16.5	22	9	14.5
EXPORT PATRICT	AMERICAN	17	49.2 N	23.1 W	11	28	M 43	5 NM	25	998.0	13.2	14.4	6	11.5	27	12	26
OLGA TOPIC	LIBERIAN	17	49.2 N	21.2 W	12	28	47	2 NM	02	996.5	12.8	15.0	9	21			
OLGA TOPIC	LIBERIAN	18	49.4 N	17.4 W	00	29	45	5 NM	01	1001.8	13.5	15.0	8	19.5			
EXPORT PATRICT	AMERICAN	18	49.6 N	14.2 W	06	30	45	5 NM	02	999.0	12.2	14.0	6	11.5	30	10	19.5
AMER LEADER	AMERICAN	18	48.3 N	13.0 W	12	30	45	10 NM	02	1005.8	15.2	13.4	6	23	30	6	26
YUKON	AMERICAN	18	39.0 N	68.6 W	06	01	45	2 NM	16	1004.1	14.5	23.3	6	8	01	9	10
LIGHTNING	AMERICAN	19	50.7 N	22.5 W	06	29	42	5 NM	15	1002.4	9.4	12.8	5	13	28	7	23
AMER CHALLENGER	AMERICAN	19	47.3 N	12.3 W	00	27	45	10 NM	03	1003.0	15.0	14.4	6	10			
LIGHTNING	AMERICAN	20	49.0 N	29.7 W	12	24	55	2 NM	25	996.0	12.2	12.2	4	19.5	23	6	29.5
ROBERT STOVE	NORWEGIAN	20	48.7 N	26.0 W	18	27	40	5 NM	16	1004.5	12.0	13.0	6	13	29	12	46
ROBERT STOVE	NORWEGIAN	21	49.6 N	22.0 W	06	27	30	10 NM	02	1006.0	12.0	13.0	6	13	27	12	42.5
EXPORT DIPLOMAT	AMERICAN	21	40.2 N	68.4 W	12	25	45	5 NM	01	999.0	18.9	21.8	5	10			
AMER LEGEND	AMERICAN	22	44.6 N	24.6 W	18	32	M 41	5 NM	25	1011.9	11.6	14.4	3	10	32	13	23
AMER CHALLENGER	AMERICAN	23	31.4 N	58.0 W	00	03	45 (H)	10 NM	21	1013.0	23.3	26.1	7	11.5			
LASH PACIFICO	AMERICAN	26	36.8 N	74.3 W	18	34	45	5 NM	25	1004.8	11.2	20.0	7	14.5			
EXPORT PATRICT	AMERICAN	26	50.6 N	32.2 W	06	28	42	10 NM	62	1005.1	7.3	12.2	5	11.5	30	7	14.5
SEALAND VENTURE	AMERICAN	27	45.5 N	20.5 W	12	32	50	1 NM	16	1000.0	11.7	14.4	4	16.5			
NORBROTT	NORWEGIAN	28	35.3 N	13.8 W	18	32	48	10 NM	03	1010.0	18.0	21.0	9	13			
SEALAND VENTURE	AMERICAN	28	44.0 N	21.8 W	00	34	45	5 NM	02	1010.5	12.8	14.4	4	13	32	>13	16.5
EXPORT DEMOCRACY	AMERICAN	29	39.7 N	55.7 W	06	01	45	1 NM	65	1006.8	14.4	23.3	2	6.5	01	< 6	11.5
AMER ACE	AMERICAN	29	41.1 N	54.7 W	12	05	45	5 NM	02	1011.0	11.7	23.3	5	11.5			
OCEAN STATION VESSELS																	
ATLANTIC M																	
TANEY	AMERICAN	21	38.0 N	71.0 W	06	21	45	5 NM	25	1000.8	22.3	25.0			16	8	16.5
GREAT LAKES VESSELS																	
G M HUMPHREY	AMERICAN	14	47.1 N	86.0 W	00	31	M 43	10 NM	25		4.0	9.0	6	6.5			
ENDERS M VOORHEES	AMERICAN	15	47.0 N	88.0 W	06	28	M 44	5 NM	03		10.0	10.0	4	10			
JOHN DYKSTRA	AMERICAN	16	45.7 N	83.6 W	00	27	M 42	10 NM	02		6.0	7.0	7	6.5			
ERNEST T WEIR	AMERICAN	22	44.3 N	82.8 W	00	25	M 42	10 NM	83		3.0	11.0	6	6.5			
WILLIAM A REISS	AMERICAN	28	44.3 N	83.0 W	12	26	M 48	10 NM	02		3.0	9.0	8	10			
J L MAUTHE	AMERICAN	28	46.9 N	91.6 W	06	23	M 44	10 NM	02		3.0	5.0	3	10			
MIDDLETOWN	AMERICAN	28	47.0 N	88.0 W	12	25	M 41	10 NM	02		4.0	7.0	3	8			
JOHN DYKSTRA	AMERICAN	31	44.4 N	82.8 W	12	02	M 41	10 NM	02		2.0	7.0	5	10			

* Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(E) Hurricane Emmy
(F) Hurricane Frances
(H) Hurricane Holly

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 11
Selected Gale and Wave Observations, North Pacific
September and October 1976

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		SEP.															
PRESIDENT MADISON	AMERICAN	9	26.0 N	127.7 E	06	32	65 (F)	.25 NM	65	976.5	26.7	28.3	11	19.5			
PRUDENTIAL SEAJET	AMERICAN	9	23.0 N	110.4 W	18	14	45 (K)	10 NM	16	1010.2	32.2	28.3	4	8	18	8	11.5
AMER ASTRONAUT	AMERICAN	9	24.5 N	123.4 E	00	33	41 (F)	4 NM	02	1001.7	29.4	28.9	7	16.5	34	8	19.5
PRUDENTIAL SEAJET	AMERICAN	10	24.3 N	111.9 W	00	18	43 (K)	5 NM	02	1006.5	29.4	27.8	5	13	18	7	18
KOREA PHOENIX	SINGAPORE	10	29.6 N	124.9 E	00	33 M	45 (F)	7 NM	02	999.5	26.0	29.0	7	23	01	10	16.5
ROMANDIE	SWISS	10	27.5 N	131.8 E	12	19 M	45 (F)	2 NM	02	999.5	27.0	28.0	5	10	04	9	16.5
ROMANDIE	SWISS	11	27.2 N	131.5 E	00	19 M	41 (F)	2 NM	02	1001.5	27.0	28.0	5	8	04	9	16.5
IDAHO	AMERICAN	11	32.1 N	125.8 E	06	03	45 (F)	2 NM	02	1004.0	23.3	25.0	3	8	03	10	16.5
KOREA PHOENIX	SINGAPORE	11	31.8 N	126.7 E	00	34 M	52 (F)	1 NM	63	999.8	20.0	28.0	7	39	01	10	26
WYOMING	AMERICAN	11	28.2 N	130.2 E	00	21	50 (F)	.25 NM		990.8	25.8	26.5	7	13			
KOREA PHOENIX	SINGAPORE	12	30.2 N	126.2 E	00	34 M	45 (F)	1 NM	65	996.5	25.0	28.0	5	32.5	01	10	23
GRAND CARRIER	LIBERIAN	13	48.7 N	126.7 W	18	14 M	45	1 NM	61	1009.5	15.2	14.0					
AMER CHIEFTAIN	AMERICAN	13	21.4 N	158.1 E	18	10	45 (H)	5 NM	51	1006.7	25.0	28.9	4	11.5	11	7	19.5
AMER CHIEFTAIN	AMERICAN	14	19.6 N	155.8 E	09	16	60 (H)	.25 NM	65	986.7	25.0	28.9	4	16.5	10	7	24.5
SHUNWIND	LIBERIAN	14	34.6 N	168.6 W	12	31 M	44	5 NM	02	977.5	8.0	9.0	8	13	31	8	16.5
UTE (ATF 76)	AMERICAN	14	53.9 N	158.7 W	18	22	50	7 NM	63	970.2	9.4	9.4		13	22	X	19.5
JAPAN RAINBOW	JAPANESE	14	51.2 N	137.3 W	06	23 M	42	2 NM	01	1004.0	11.0	13.0					
R C FOLLIS	LIBERIAN	14	14.1 N	146.4 E	18	27 M	42 (G)	5 NM	25	999.0	27.5	29.5	7	13	27	>13	16.5
AMER CHIEFTAIN	AMERICAN	15	18.5 N	155.7 E	00	23	45 (H)	2 NM	14	1003.1	28.3	28.9	5	14.5	22	8	21
ROBERTS BANK	LIBERIAN	15	54.0 N	153.0 W	00	22 M	55	2 NM	51	984.0	10.8	10.0	4	10	22	6	11.5
MAINE	AMERICAN	15	54.5 N	154.0 W	06	24	45	2 NM	61	986.2	10.0	8.3	4	16.5	23	11	29.5
GOLDEN ARROW	JAPANESE	17	45.0 N	153.1 W	18	17 M	44	5 NM	02	1001.0	14.5	7.0	5	10	18	9	13
MILLYER BROWN	AMERICAN	17	56.7 N	147.7 W	18	16	42	5 NM	02	1002.0	10.0	11.7			16	7	10
JAPAN BEAR	AMERICAN	17	37.5 N	155.0 E	00	15 M	42 (H)	5 NM	01	1008.5	24.4	20.6		10	15	X	16.5
CARRETERA	PANAMANIAN	17	34.7 N	155.7 E	06	16 M	43 (H)	.5 NM	07	1004.0	27.0	26.0	6	13	16	8	26
ATLANTIC PIONEER	PANAMANIAN	17	52.7 N	154.5 W	18	22 M	50	.25 NM	56	979.0	7.0	9.0	8	31	18	8	32.5
MATHILDE MAERSK	DANISH	17	31.8 N	155.6 E	00	13	48 (H)	5 NM	05	1008.0	26.0	25.0	10	16.5			
SEVILLAN REEFER	LIBERIAN	17	37.8 N	150.7 E	00	14	50 (H)	1 NM	10	967.5		26.0	XX	23			
KOREA PHOENIX	SINGAPORE	17	44.8 N	152.9 E	12	10 M	48 (H)	.5 NM	05	993.0	13.0	13.0	6	16.5			
ARCTIC TOKYO	LIBERIAN	18	47.6 N	153.6 E	12	19 M	50 (H)	50 YD	53	983.0	7.0	11.0	XX	19.5			
SHUNWIND	LIBERIAN	18	49.5 N	161.6 E	06	11 M	65 (H)	.5 NM	63	984.5	10.0	11.0		23	14	X	26
ATLANTIC PIONEER	PANAMANIAN	18	52.8 N	152.3 W	00	23 M	40	1 NM		999.5	10.0	9.0	10	19.5	18	>13	32.5
JAPAN RAINBOW	JAPANESE	18	54.1 N	163.1 W	00	32 M	42	2 NM	02	983.5	8.0	7.5					
BELMAR	NORWEGIAN	18	42.5 N	150.0 E	00	27	50 (H)	10 NM	03	995.0	17.0	19.0	8	21			
PACSTAR	LIBERIAN	18	54.4 N	150.8 W	00	19	52	2 NM	02	999.4	9.0	10.0	9	19.5	19	>13	32.5
SHUNWIND	LIBERIAN	19	48.7 N	159.3 E	03	24 M	52 (H)	2 NM	07	979.0	8.5	10.0		28	22	X	36
PHILADELPHIA	AMERICAN	20	58.1 N	148.6 W	18	12	45	2 NM	51	989.7	12.8	10.0	4	6.5	12	8	11.5
PRES FILLMORE	AMERICAN	20	48.5 N	164.3 E	00	27	48 (H)	5 NM	01	987.0	10.0	12.8	6	10	27	9	16.5
MAINE	AMERICAN	20	49.0 N	166.0 E	00	28	40 (H)	5 NM	02	992.0	10.0	8.9	3	10	28	9	34.5
JAPAN BEAR	AMERICAN	21	44.5 N	153.6 W	06	15 M	45	3 NM	62	998.5	11.7	12.2	4	13			
AMER ARCHER	AMERICAN	22	24.9 N	153.7 E	00	20	50 (J)	1 NM	65	998.3	25.6	28.4	10	14.5			
JAPAN BEAR	AMERICAN	22	43.0 N	141.5 W	06	20 M	50	5 NM	50	1010.5	16.1	14.4		10	16	X	16.5
SUMIC INTREPID	AMERICAN	25	43.9 N	179.5 E	06	29	55	2 NM	02	990.0	11.1	11.7	7	11.5	23	8	16.5
CHESHIRE	BRITISH	27	37.4 N	169.6 E	06	03	50	5 NM	50	1012.5	17.5	19.5	6	14.5	03	6	24.5
SEALAND EXCHANGE	AMERICAN	27	36.9 N	145.7 W	12	33	47	5 NM	02	1007.5	17.0	19.2	4	10	33	9	23
ALASKAN MAIL	AMERICAN	28	53.4 N	177.4 W	00	35	45	10 NM	18	993.2	8.9	6.7	5	14.5	34	< 6	19.5
VEMA R/V	PANAMANIAN	28	37.8 N	145.7 E	18	17	48	1 NM	50	976.2	20.3	21.3	3	6.5	17	< 6	10
GOLDEN GATE	AMERICAN	28	35.1 N	142.0 E	06	36	45	2 NM	20	963.2	21.7	22.3	3	11.5	36	6	18
PEARL VENTURE	LIBERIAN	28	41.2 N	153.5 E	06	09	44	1 NM		1018.0	16.0	19.0	4	10	10	7	14.5
PRES TRUMAN	AMERICAN	28	38.0 N	143.7 E	18	29	60	200 YD	07	991.2	18.3	18.3		19.5			
SUMIC INTREPID	AMERICAN	28	45.5 N	146.2 W	18	21	48	2 NM	00	1006.1	14.4	13.3	6	10	22	< 6	19.5
VEMA R/V	PANAMANIAN	29	38.3 N	145.8 E	00	32	60	50 YD	07	991.1	20.2	21.7	4	8	XX	X	10
VAN CONQUEROR	LIBERIAN	29	41.0 N	151.9 E	12	27 M	50	.5 NM	51	980.0	14.0	18.0					
INGER	AMERICAN	29	19.9 N	106.0 W	18	12	60 (L)	1 NM	82	1001.0	27.2	30.6	6	24.5	16	10	32.5
PEARL VENTURE	LIBERIAN	29	41.6 N	158.1 E	00	11	48	1 NM	61	1008.0	15.0	13.5	5	8	12	8	16.5
HAWAIIAN PROGRESS	AMERICAN	29	23.9 N	152.3 W	18	07 M	42 (K)*	5 NM	21	1007.0	25.0	26.6	6	16.5			
PEARL VENTURE	LIBERIAN	30	42.2 N	164.5 E	06	27	50	.5 NM	46	994.0	13.0	11.0	7	13	24	9	26
ALASKAN MAIL	AMERICAN	30	47.9 N	157.1 E	06	34	45	10 NM	01	1002.4	8.9	8.3	5	10	33	7	19.5
WORLD PRIDE	LIBERIAN	30	42.0 N	154.1 E	00	33	42	5 NM	58	1010.0	11.5	10.0	3	8	38	< 6	18
INGER	AMERICAN	30	19.4 N	105.3 W	06	15 M	45 (L)	10 NM	02	1007.1	27.7	29.4	4	13	20	10	24.5
ASTA BRAVERY	LIBERIAN	30	44.4 N	173.7 E	18	26 M	58	.5 NM	42	991.6	11.5	12.0	3	10	26	8	21
NORTH PACIFIC OCEAN		OCT.															
MAMMOTH PINE	LIBERIAN	1	48.1 N	178.4 E	00	24 M	90	.5 NM	02	980.0	9.0	11.0			23	X	37.5
PEARL VENTURE	LIBERIAN	1	43.0 N	169.3 E	00	29	48	2 NM	80	1011.0	11.0	12.0	6	13	31	8	21
S P LEE	AMERICAN	1	49.5 N	176.2 E	06	25 M	58	2 NM	02	972.9	6.7	8.0	6	10	25	12	41
HARRY LUNDEBERG	PANAMANIAN	1	23.6 N	109.5 W	06	22	45 (L)	7 NM	30	1002.5	27.0	29.2	3	18	18	7	6.5
ASTA BRAVERY	LIBERIAN	1	45.3 N	178.0 E	06	26 M	48	1 NM	10	997.5	10.5	12.0	3	8	27	9	21
TRIUMPH	PANAMANIAN	2	46.6 N	176.8 E	00	29 M	48	2 NM	02	997.8	7.0	11.0	9	10	29	12	14.5
MAMMOTH PINE	LIBERIAN	2	49.7 N	175.0 W	00	19 M	50	1 NM	16	982.0	8.0	11.0	6	21	23	13	39
PEARL VENTURE	LIBERIAN	2	43.3 N	176.2 E	00	28	42	5 NM	02	1013.0	9.9	9.0	6	11.5	29	8	23
S P LEE	AMERICAN	2	49.3 N	175.9 E	00	28 M	58	2 NM	02	981.8	7.2	8.0	6	10	28	12	46
ASTA BRAVERY	LIBERIAN	2	46.7 N	176.4 W	00	24 M	41	2 NM	02	993.5	9.0	12.0	3	6.5	24	8	16.5
S P LEE	AMERICAN	3	49.3 N	175.0 E	00	30 M	38	2 NM	02	999.8	6.7	7.0	6	10	30	10	36
PEARL VENTURE	LIBERIAN	3	43.2 N	176.3 W	00	28	44	5 NM	02	1010.5	11.5	10.0	6	11.5	29	9	24.5
VAN WARRIOR	LIBERIAN	3	49.4 N	169.5 W	06	25	48	1 NM	50	980.0	11.0	9.0					
VAN WARRIOR	LIBERIAN	6	48.1 N	173.8 E	00	18	45	1 NM	64	1000.0	11.0	8.0					
VEMA R/V	PANAMANIAN	6	34.2 N	152.1 E	06	28	48	5 NM	20	1003.2	23.6	24.8	3	6.5			
ATLANTIC PIONEER	PANAMANIAN	6	48.7 N	171.5 E	12	27 M	50	1 NM	05	1005.5	8.0	8.0	8	29.5	18	9	29.5
ECUADORIAN REEFER	DANISH	7	16.0 N	101.0 W	18	13	56 (M)	2 NM	64	1002.0	28.0	26.0	6	23			
AUSTRAL LIGHTNING	AMERICAN	7	18.5 N	100.4 W	21	10	55 (M)	2 NM	65	1007.5	23.9	28.3	4	10	13	7	13
KINNA MAN	DANISH	7	31.3 N	147.6 W	00	18	44	1 NM	82	1000.5	21.0		10	16.5			
CHEVRON GENOA	PANAMANIAN	7	16.7 N	100.2 W	21	11 M	45 (M)	2 NM	64	1000.5	24.0	26.8	XX	26			
TRANSONEIDA	AMERICAN	8	36.5 N	150.4 W	00	33	42	5 NM	51	1003.7	15.6	20.0	10	18			
ADRIAN MAERSK	DANISH	8	48.0 N	176.8 E	06	24	36	1 NM	07	992.2	9.0	8.0	7	26			
AUSTRAL LIGHTNING	AMERICAN	8	17.5 N	102.0 W	18	36	99 (M)	.5 NM	65	970.2	23.3	28.3	4	18	06	7	24.5
KINGSVILLE	NORWEGIAN	8	17.5 N	103.2 W	06	36	55 (M)	1 NM	81	998.0	26.5	31.0					
ATLANTIC PIONEER	PANAMANIAN	8	46.0 N	161.9 E	00	27 M	50	2 NM	50	1008.2	8.0	8.0	8	29.5	27	9	29.5

Vessel	Nationality	Date	Position of Ship Lat deg.	Position of Ship Long deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		OCT.															
CHALMETTE	LIBERIAN	8	35.3 N	150.0 W	00	32	45	200 YD	83	1001.8	14.5	20.0	7	13	33	< 6	19.5
MEDINA	DANISH	8	17.3 N	103.1 W	12	26 M	30 (M)	.5 NM	85	997.5	28.5		10	16.5			
CHEVRON GENOA	PANAMANIAN	8	16.5 N	99.7 W	00	11 M	43 (M)	2 NM	84	1003.0	25.0	26.8	XX	26			
SAN JUAN	AMERICAN	8	17.6 N	102.6 W	06	07	25 (M)	1 NM	83	998.9	25.0	28.7	4	19.5	12	8	24.5
VAN WARRIOR	LIBERIAN	8	45.4 N	161.2 E	06	30	35	2 NM	03	1007.0	7.0	8.0					
OVERSEAS JUNEAU	AMERICAN	10	39.0 N	151.4 E	18	18 M	15	5 NM	14	982.7	20.0	17.3	7	16.5	17	10	39
NORSE PILOT	BRITISH	11	38.7 N	146.9 E	06	28 M	45	5 NM	18	1011.4	16.0	18.0	3	5	26	8	18
ATLANTIC PIONEER	PANAMANIAN	11	37.5 N	144.3 E	06	27 M	45	2 NM	03	1009.5	17.0	14.0	9	16.5	27	9	24.5
MADONNA	LIBERIAN	11	39.3 N	151.3 E	00	30 M	42	10 NM	01	997.0	19.5	20.0	6	14.5	32	9	13
OVERSEAS JUNEAU	AMERICAN	11	38.5 N	150.9 E	00	32 M	55	10 NM	15	982.7	20.5	17.3	8	19.5	32	10	32.5
HONSHU MARU	JAPANESE	12	47.8 N	175.2 E	00	14 M	42	.5 NM	83	1002.7	9.0	7.0	6	13			
GOLDEN MARINER	PANAMANIAN	13	51.1 N	178.7 E	21	23 M	41	10 NM	02	999.1	7.0	7.0			25	9	28
EXPORT COURIER	AMERICAN	14	39.0 N	152.4 W	00	36	45	5 NM	30	1020.0	13.0	15.6	3	13	36	8	32.5
GOLDEN MARINER	PANAMANIAN	14	51.4 N	179.3 E	15	24 M	41	5 NM	02	995.0	5.0	6.0	6	8	23	7	13
LAUREL	LIBERIAN	18	50.3 N	157.2 W	18	13 M	41	2 NM	21	998.0	7.9	8.0	5	11.5	13	6	23
OPHELIA	LIBERIAN	19	48.2 N	166.2 E	00	22 M	51	2 NM	84	1001.0	7.8	6.0	7	13	26	>13	29.5
OPHELIA	LIBERIAN	21	43.1 N	152.2 E	06	16 M	41	1 NM	10	995.4	13.0	8.0	7	6.5	14	>13	23
MAMMOTH PINE	LIBERIAN	22	50.2 N	147.7 W	00	14 M	42	2 NM	02	1002.4	10.1	10.0		18			
CRESSIDA	PANAMANIAN	25	48.8 N	156.2 E	12	09 M	50	1 NM	30	1002.0	6.5	6.0	8	13			
ASIA BRAVERY	LIBERIAN	25	44.6 N	153.2 E	06	11 M	50	.25 NM	45	993.0	9.5	11.0	5	34.5			
PACIFIC WING	PANAMANIAN	25	34.7 N	152.2 E	00	17 M	45	5 NM	07	1001.0	24.0	22.0	4	10			
WASHINGTON	AMERICAN	26	49.3 N	144.0 W	00	17 M	56	5 NM	51	996.6	13.2	10.0	5	10	19	12	16.5
PHILADELPHIA	AMERICAN	27	38.4 N	148.6 W	00	27	45	5 NM	85	981.0	0.6	8.3	5	14.5	27	6	24.5
MARCONA EXPORTER	LIBERIAN	28	21.8 N	110.6 W	21	18	43 (N)	10 NM	02	1001.5	28.0	27.0	6	10	22	8	14.5
HONGKONG PHOENIX	SINGAPORE	28	34.1 N	142.9 E	12	23	42	10 NM	30	1001.8	20.0	23.0	7	18	29	9	23
MAMMOTH PINE	LIBERIAN	29	40.4 N	150.5 E	21	24 M	60	1 NM	82	998.0	12.1	14.0	8	21			
MENELEUS	FRENCH	29	37.1 N	158.3 E	06	18 M	42	10 NM	02	1011.0	20.3	19.7	5	14.5			
PRES TRUMAN	AMERICAN	29	38.5 N	135.5 E	00	27	60	5 NM	80	999.7	8.0	18.0	8	29.5			
TRULL RIVER	BRITISH	29	34.9 N	141.7 E	06	24 M	50	5 NM	07	1001.5	20.0		8	16.5			
PANAMTER	PANAMANIAN	30	48.5 N	157.6 E	18	27 M	50	.25 NM	05	1001.8	7.0	7.5	4	11.5	27	7	13
PORTLAND	AMERICAN	30	55.6 N	141.9 W	12	20	47	5 NM	60	960.6	8.4	8.9	5	10	20	7	14.5
PHILADELPHIA	AMERICAN	30	56.0 N	148.2 W	12	36	60	2 NM	85	963.8	3.9	7.8	4	19.5	04	>13	41
PHILADELPHIA	AMERICAN	31	53.9 N	149.5 W	00	27	45	5 NM	51	978.0	3.9	7.8	6	19.5	32	>13	32.5
NORBU	NORWEGIAN	31	51.9 N	168.0 E	00	09	42	1 NM	51	1000.0	3.9	2.0		19.5			
PORTLAND	AMERICAN	31	57.4 N	148.7 W	00	29	60	5 NM	51	957.5	3.3	7.7	4	19.5	29	12	23
SANTA MARIA	AMERICAN	31	41.9 N	133.9 W	18	28	50	5 NM	18	998.0	9.1	11.7	7	16.5			

* Direction for sea waves: same as wind direction
X Direction or period of waves indeterminate
M Measured wind

(F) Supertyphoon Fran
(G) Hurricane Kathleen
(G) Tropical storm Georgia
(H) Typhoon Hope
(J) Typhoon Joan
(K)* Hurricane Kate (central Pacific)
(L) Hurricane Liza
(M) Hurricane Madeline
(N) Tropical storm Naomi

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

(Continued from page 119.)

SEPTEMBER DATA SUMMARY EB04
AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.7	(11 09)	27.2	30.7	(01 21)	237	30
DEWPOINT TEMP (DEG C)	17.8	(18 06)	23.3	26.7	(23 00)	229	30
PRESSURE (MBAR)	1009.1	(22 09)	1014.8	1020.8	(09 15)	237	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.7	5.2	1.3				8.9	7.2
NE	1.3	9.6	7.4				18.3	9.7
E	2.6	13.5	8.3				24.5	8.8
SE	.4	7.0	2.6				10.0	8.6
S	.9	10.5	6.4				19.7	9.2
SW	2.7	4.4	4.2				11.8	8.5
W	1.7	3.9	1.7				7.4	8.7
NW	1.3	2.2	.4				3.9	5.7
CALM								
TOTAL	12.2	56.3	31.4				100.0	8.5

NO. OF OBS: 229
MAX WIND
SPEED: 18 KNOTS
DIRECTION: 130 DEG
DAY: 22
HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 79

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	19.7	20.3							.6M	1.5M	(23 12)

PRECIPITATION
NO. OF DAYS WITH PRECIP: 9 NO. OF DAYS WITH REPORTS/ COMPLETE: 28 PARTIAL: 2
NO. OF OBS WITH PAST OR PRESENT PRECIP: 28 NO. OF WEATHER OBS: 28

SEPTEMBER DATA SUMMARY EB41
AVERAGE LATITUDE 38.7N AVERAGE LONGITUDE 073.6W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.5	(06 18)	20.0	21.8	(04 21)	53	7
SEA TEMP (DEG C)	19.8	(07 18)	21.0	22.6	(04 21)	53	7
AIR-SEA TEMP (DEG C)	-03.1	(01 00)	-01.0	00.8	(04 03)	53	7
PRESSURE (MBAR)	1011.2	(05 21)	1019.9	1025.0	(09 15)	53	7

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4- 10	11- 21	22- 33	34- 47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.9	1.9	14.1				18.9	14.5
NE		1.9	9.4				11.3	14.7
E	3.8	3.8					7.5	4.3
SE		7.5					7.5	6.0
S		9.4	13.2				22.6	11.0
SW		11.3	5.7				17.0	9.1
W		3.8	1.9				5.7	10.0
NW		1.9	5.7				7.5	11.5
CALM	1.9						1.9	.0
TOTAL	7.5	41.5	50.9				100.0	10.6

NO. OF OBS: 53
MAX WIND
SPEED: 21 KNOTS
DIRECTION: 010 DEG
DAY: 06
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 54

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	13.0	81.5	5.6						1.1M	2.0M	(03 15)

Rough Log, North Atlantic Weather

December 1976 and January 1977

ROUGH LOG, DECEMBER 1976--Normal cyclonic activity was concentrated from Nova Scotia to the Davis Strait and from Newfoundland through the Denmark Strait. Some storms also moved along the U.S. East Coast, in the North Sea, and the Mediterranean. An even more-than-normal flurry of activity occurred around the Gulf of St. Lawrence, resulting in a negative 6-mb sea surface pressure anomaly. This also caused a shift in the 1000-mb center of the climatic Icelandic Low from around Iceland to the seas between Greenland and Newfoundland. Less-than-normal activity left the Iceland region with a positive 11-mb anomaly at the surface and a positive 93-m anomaly at the 700-mb level.

A southwestward shift in the normal position of the 1021-mb Azores High from around the Azores to near 30°N, 40°W, caused a positive 4-mb surface pressure anomaly in these waters and a positive 28-m anomaly at 700 mb. Around the Azores, this shift and some weak storm activity resulted in a deficit of 8 mb at the surface and 80 m at 700 mb.

The month opened with a huge quasi-stationary 1030 plus mb HIGH, centered southwest of the Azores, dominating most of the weather south of 40°N. Over Europe lay the large, multicentered remains of a low-pressure system that had its origins back in November. The gradient between these two systems was responsible for the northwesterly gales and rough seas from the Bay of Biscay to Ireland. (See November Rough Log in January 1977 issue.)

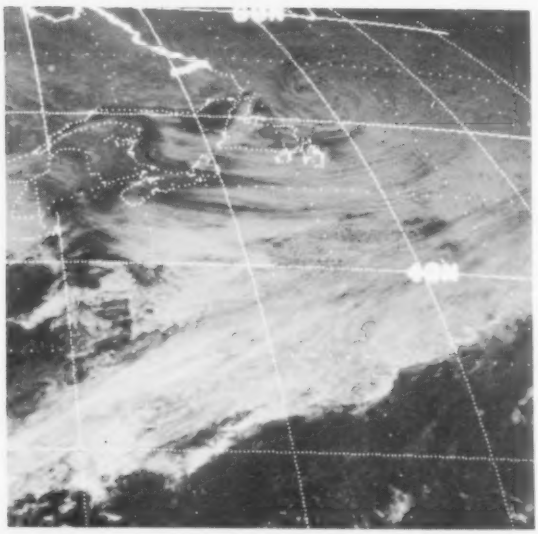

Figure 56.--The storm's center can be seen near 53°N, 50°W, in the oblique view from SMS-2.

Extratropical Cyclones--The first major storm of December was spawned by the Great Lakes on the 1st and nutured by the St. Lawrence River. By the 4th (fig. 56) its 970-mb center was off the Labrador coast, and it was generating gales and rough seas out 500 mi to the south and southeast. The TORDALSFJORD ran into 30-ft seas in 50-kn winds some 300 mi southeast of the center. The LOW moved eastward across the North Atlantic at about 55°N. On the 5th the ATLANTIC CAUSEWAY battled 28-ft swells in 65-kn winds some 400 mi southwest of the 960-mb center, which was crossing the 30th meridian. The LOW reached a peak early on the 7th, when pressure fell to 956 mb. During this period, ships such as the DCHO and the KAUNAS QUEENSGARTH were reporting 50- to 60-kn winds from near the center out 500 mi to the west and south. It was about this time that the LOW turned northward brushing the Hebrides and finally moving into the Norwegian Sea where it filled a few days later.

Between the 9th and 15th, a series of rapidly moving, gale-producing LOWs moved northward across the shipping lanes of the northwestern North Atlantic. The first of these originated as a frontal wave in South Carolina on the 7th. It was of little consequence until the 10th when it deepened rapidly south of Greenland. In 24 hr pressure fell from 986 mb to 938 mb. Winds of 45 kn were reported as far as 900 mi to the south. The ALSTER EXPRESS, EVELYN BOLTEN, EAGLE CHARGER, DXYL, and the BUOY were encountering winds of 45 to 60 kn with seas up to 35 ft. As this LOW began to fill on the east coast of Greenland, it was followed by another system that moved off the coast of Newfoundland on the 12th.

This storm originated in the Canadian Rockies, west of Calgary, on the 8th. It swung southeastward through the upper Midwest, then east-northeastward across the Great Lakes, where it began to organize on the 10th. Early on the 12th, sporting a 986-mb center just east of Newfoundland, the storm was generating 40- to 50-kn winds to the south, particularly behind its cold front, which extended back over the Carolinas. Moving northeastward, the storm continued to intensify to a peak of about 964 mb on the 12th. The IVAN AIVAZOVSKII encountered 50-kn winds, while the EVELYN BOLTEN ran through the front encountering 55-kn winds in 25-ft swells. Like the previous storm, this one petered out on the southeast coast of Greenland.

The next member of this storm trio developed south of Nova Scotia early on the 13th. Developing rapidly, the system raced northeastward across Newfoundland and then turned northward toward the Davis Strait. By the 14th the central pressure bottomed out at 948 mb, and 40- to 50-kn winds were being encountered out 500 mi to the south. Seas were running up to 20 ft. Frederikshab reported 60-kn easterly winds as

Figure 57.--A Coast Guard cutter stands by the grounded ARGO MERCHANT before the vessel split in two and dumped her cargo into the North Atlantic. U.S. Coast Guard Photo.

the storm center roared within 60 mi. At the same time the MANCHESTER CONCORDE battled 50-kn westerlies in 20-ft seas some 480 mi to the south. As the system entered the Davis Strait, it began to fill.

After a brief respite, another Newfoundland storm came to life as a frontal wave off the coast of Georgia on the 15th. This was the same day that the ARGO MERCHANT, carrying 182,600 barrels of No. 6 fuel oil, ran aground on Nantucket Shoals (fig. 57). The storm intensified and developed a second center as it moved northward. By the 17th its 40-kn winds and 15-ft seas in near-freezing temperatures prevented the Coast Guard oil cleanup team from going into action. The storm's new 972-mb center moved into the Gulf of St. Lawrence early on the 18th. Gales extended 600 mi to the south and east. In the Nantucket area, winds of 35 to 40 kn were common.

Within 4 days after the grounding more than 1.5 million gallons (about 20 percent of the cargo) had spilled and were being pushed southeastward. Meanwhile, the storm--which had deepened to 960 mb late

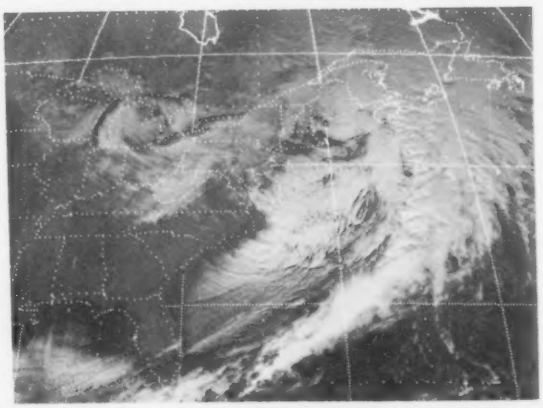

Figure 58.--The cloud formation behind the cold front indicates the instability and turbulent conditions that contributed to the ARGO MERCHANT breaking up.

Figure 59.--This photograph shows the ARGO MERCHANT on the 28th, a week after it split in two. The bow has turned turtle in the turbulent seas after swinging around toward the stern. See figure 46 on page 94. U.S. Coast Guard Photo.

on the 18th--moved northward and stalled between Labrador and Greenland on the 20th. It filled rapidly, but another system was beginning to affect the waters around Nantucket.

This new storm was spawned over Nebraska on the 19th. It intensified as it moved east-northeastward across the Great Lakes the following day. The LOW was spreading rain out 600 mi from its 994-mb center. Just as it reached the coast of Maine, the deepening 977-mb LOW turned northward on the 21st. Afternoon temperatures hovered in the teens and in single numbers in the North Atlantic States, and gale warnings extended from Maine to Virginia (fig. 58). New York and Boston reported 42-kn gusts. Battered by high seas, the ARGO MERCHANT broke in two early on the 21st (fig. 59). About 80 percent of its cargo was spilled in 50-kn winds and 20-ft seas. Early the next day, the forward section of the grounded tanker cracked, rupturing the forward cargo holds and releasing nearly all 36,000 barrels of oil remaining in the vessel. Northwesterly winds pushed the oil slicks toward the east-southeast. Meanwhile, the storm had deepened to 966 mb as it moved northward across eastern Quebec. The GUZJ ran into 60-kn winds off the coast of Maine. The ERAWAN, about 300 mi to the east, reported 45-kn winds in 30-ft swells. On the 23d the system weakened and turned northwestward up the Hudson Strait. It finally ended up over Hudson Bay on the 25th.

A LOW developed along a front over northern Montana early on the 27th. It intensified very little as it moved east-southeastward through the Ohio Valley and across southern Pennsylvania on the 28th. However, once out into the Atlantic the storm turned northeastward and began to deepen. By early on the 30th, the now northward-moving, 979-mb LOW was centered just 100 mi south of Nova Scotia. Near its center winds were blowing about 40 kn and seas were running 15 to 20 ft. On the 29th at 1800, the FORELAND (37.8°N, 70.5°W) reported northwesterly winds at 55 kn, while 500 mi farther east the MUENCHEN encountered 28-ft swells. It was on the 30th (fig. 60)

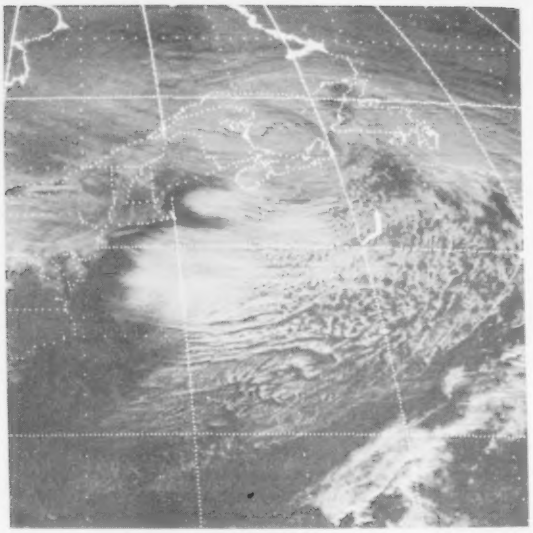

Figure 60.--By 1700 the center of the LOW has moved into the Gulf of St. Lawrence. The GRAND ZENITH disappeared in the area of turbulent and unstable conditions behind the front.

that the Panamanian tanker GRAND ZENITH, carrying 8 million gallons of heavy fuel oil, was last heard from about 30 mi from Cape Sable, Nova Scotia. In her last communication she reported very strong westerly winds and heavy seas. At 1200 the 964-mb center was in the Gulf of St. Lawrence. A few hours later some 350 mi southeast of Cape Sable, the DLHO reported 60-kn winds in 30-ft seas. The storm was at its peak on the 30th. It then stalled and began to fill over southern Labrador.

Out of a complex, multicentered low-pressure system that covered northern Europe and Scandinavia, a LOW developed about 250 mi northwest of Ireland on the 29th. Winds of 55 to 60 kn were already being reported by the OSTROV RUSSKIY and the URYX. Early on the 30th, the C7L, about 240 mi northwest of the center, battled 23-ft seas in 50-kn winds. The storm meandered southeastward, then turned northward on the 31st, crossing the Hebrides. Winds of 50 to 60 kn were common in the North Sea. The ZAFRA encountered 60-kn southerlies in 35-ft seas. The CHRZANOW ran into several consecutive days of 52- to 58-kn southerlies as she sailed westward along the coast of the Netherlands. In addition, she ran into another storm with 66-kn winds in the English Channel on January 1. By this time the original LOW was filling over the Norwegian Sea.

Casualties--The RAUTE touched bottom at Gooseneck Shoal in heavy snow and anchored at Morrisburg Channel, St. Lawrence River, on the 3d. On the 7th the HARRY L. ALLEN and the JAN T. HUTCHINSON became stuck in the ice while downbound in Lake St. Clair.

The worst traffic jam in 50 yr tied up more than 60 vessels on the St. Marys River on the 11th as the 716-ft ore carrier CLIFFS VICTORY ran aground in a shallow section of Neebish Channel while trying to avoid ice jams.

On the 26th the 42-ft sloop MYSTERE was abandoned in heavy weather off Cape Fear. The ship had encountered rough weather early that morning. By noon winds were gusting to 70 kn, and 20-ft seas were making conditions impossible. The Coast Guard was standing by; finally, after five passes the Swedish tanker FORT ALEZA was able to take the four-man crew aboard. Weather was too rough, however, to take the MYSTERE in tow.

ROUGH LOG, JANUARY 1977--Storm activity was near normal this month. The tracks over the water were generally south and east of the climatological tracks. There was a clear-cut concentration of storm-center paths over the Great Lakes, but most of these curved northward over Quebec and Labrador and did not significantly affect the open sea. The cyclones out of the eastern United States generally had a more easterly component than the climatic normal, with about half curving northward to buffet Newfoundland and the other half continuing eastward and then turning northward south of Iceland. An inverted high-pressure ridge over Greenland protected the sea around and north of Iceland. During the second and fourth weeks of the month, several storms moved across Europe, preferring the English Channel. The last week three storms affected the Mediterranean Sea. One storm moved northward across the Azores from the vicinity of 21°N, 40°W.

The mean low-pressure centers at 1000 mb and 1005 mb were within 1 mb of the climatic normal pressure but were greatly shifted southeastward from their normal position. A 1001-mb center normally near 60°N, 35°W, was 1000 mb near Belle Isle. The 1005-mb secondary Low normally off the central coast of Norway was 1005 mb between Iceland and Ireland. The Azores High was 1023 mb along latitude 30°N south of the Azores. The pressure over the eastern third of the United States was less than normal.

The most intense pressure anomaly was a positive 15-mb center between Greenland and Iceland near 63°N, 35°W. A large negative anomaly had three 9-mb centers--near James Bay, the Gulf of St. Lawrence, and near 40°N, 60°W. A negative 5-mb center was over the English Channel.

The upper-air circulation at 700 mb had the same general configuration as climatology, but it was shifted slightly to the south and east over the eastern Northern Hemisphere. The primary Low center was near 53°N, 70°W, rather than northern Baffin Island. The trough line basically paralleled the U.S. East Coast instead of west of the Appalachian Mountains. The slight ridge that normally exists over western Europe was shifted westward and replaced by a shallow trough. A very sharp ridge replaced the slight ridge that normally occurs over the West Coast from California to Alaska. This resulted in much colder air from northern Canada being advected over the eastern United States. The primary anomaly centers were positive over the U.S. West Coast and negative over New England and northwestern Europe.

Extratropical Cyclones--The first severe LOW of the new year originated over the Gulf of Mexico on the 2d. It moved along the Gulf Coast, over northern Florida, and on the 4th was over the Gulf Stream off Cape Hatteras. At 1200 on the 5th, it was 994 mb near 40°N, 60°W. Twelve hours later, it was 980 mb about 100 mi south of Argentia. The CHASTINE MAERSK was 210 mi southeast of the center near 42.5°N, 54°W, with 40-kn southwesterly winds, but the seas were climbing 38 ft up her bow, while the swells from 160° were slamming 30 ft against her portside. The SHAFTAFEU was just outside St. Marys Bay with 45-kn winds.

The storm continued on a northerly course, and by 0000 on the 7th it was west of Kap Farvel. It slowly moved up the west coast of Greenland and broke upon the rocky shore and cold ice.

On the 7th, a warm front extended across central Florida to just off Cape Hatteras. At 1200 a wave formed on the front near Hatteras. It developed extremely rapidly. In 12 hr the pressure dropped from 996 mb to 970 mb off Cape Cod. At 1800 the ARECIBO and STRATHAIRD were both in the vicinity of 33.5°N, 71°W, with 60- and 50-kn winds, respectively. At 0000 on the 8th, the SEVERNYY VETER (40.5°N, 71.7°W) and the CG11 (43.4°N, 65.6°W) experienced 60-kn winds from opposite directions as they straddled the LOW. At 0600 OWS Hotel fought 50-kn winds and 26-ft seas (fig. 61).

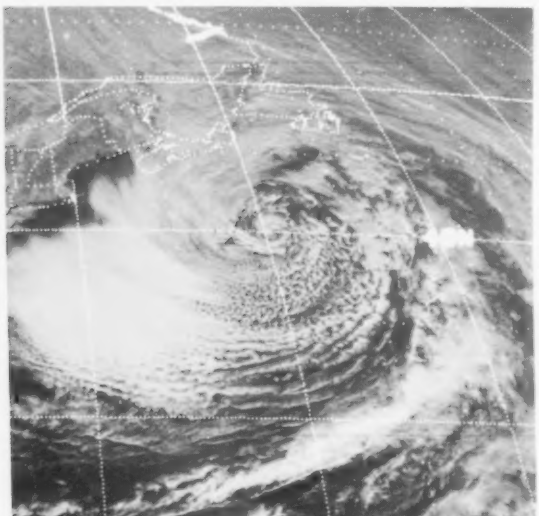

Figure 61.--There is no doubt where the center of this storm is at 1700 on January 8, 1977. High winds and waves resulted in the CHESTER A. POLING breaking up 48 hr later.

Forty and 50-kn winds continued, and at 0000 on the 9th, the LOW was near 41°N, 55°W, at 977 mb. The LUTZ JACOB was at 35.5°N, 58.9°W, with 64-kn northwesterly winds. The swells were 30 ft. Later in the day, the storm started to weaken; by 0000 on the 10th, it was only a trough behind the front.

The empty tanker CHESTER A. POLING broke up about 6 mi off Cape Ann on the 10th. The winds were reported as 60 kn and the waves 35 ft. Six crewmen were saved by the Coast Guard cutter CAPE GEORGE and by helicopter. One crewman was lost.

A LOW which began over Louisiana moved northeastward on the 9th. On the 10th a frontal wave formed southeast of the original LOW as it moved northward over Ohio. At 1200 on the 10th, the wave was only 995 mb, but it was still associated with the overall circulation of the parent LOW. As the storm center was over Cape Charles, the OVERSEAS NATALIE (36.5°N, 71.6°W) had 50-kn southerly winds and 23-ft seas and swells. At 1800 OWS Hotel reported 52-kn storm winds and 26-ft seas, which continued into the 11th. Both the GYPSUM EMPRESS and VGBZ were in the eastern part of the storm with 60-kn winds. At 1200 the THUREDRECHT (40.7°N, 59.8°W) was helped along by 63-kn winds on her stern. Waves of 23 ft were rocking her. On the 12th the 986-mb LOW was headed into northern Quebec. Gale-force winds were still blowing south and east of the Maritime Provinces. At 1200 the GWENOLA, well south of the center at 41.3°N, 65.9°W, radioed 72-kn winds from the west. The Norwegian TEMERAIRE sustained a crack in its portside 180 mi southwest of New York. The seas in the area were reported as 24 ft with 40-kn winds. On the 13th the LOW was over Hudson Bay and headed northwestward.

A small closed circulation was revealed by a report from an unidentified ship in an area of weak gradient near 37°N, 62°W, on the 0000 chart of the 13th. It developed very rapidly and was 990 mb by 1200 and about 900 mi in diameter. The KURRYSHEVGES was about 360 mi southwest of the center with 45-kn winds and 36-ft seas. Forty- to 50-kn winds were reported several times.

At 1200 on the 14th, the storm's central pressure had plunged to 974 mb near 48°N, 48°W. The HUMERGATE, near 41.4°N, 53.5°W, had 50-kn winds, 28-ft seas from the northwest, and 39-ft swells from the north on her westerly track. About 600 mi directly south of the center the OROTAVA BRIDGE was running with 43-ft swells on her stern. Swell of over 25-ft was not uncommon. At 1800 a ship west of Kap Farvel was blasted by 64-kn winds. Two other ships about 300 mi south and west of the center had winds in the 50-kn category. The MANCHESTER CHALLENGE (46.4°N, 46.6°W) suffered 50-kn winds and 30-ft waves. On the 15th, OWS Charlie fought 56-kn winds and 20-ft seas. As the storm moved north of the east coast of Newfoundland, it weakened and died on the 17th.

The storm-breeding ground off the Carolina Capes also spawned this monster on the 15th. As usual, it developed rapidly as the cold air moved over the warm Gulf Stream. By 1200 the 988-mb LOW was at 39°N, 68°W. The TROLL PARK was at 35.6°N, 65.7°W, with 60-kn southwesterly winds and 20-ft waves. A ship reported 50-kn winds and 33-ft swells very near the center.

This storm was moving eastward instead of north to northeastward as the previous one did. Under the zonal flow, it was racing along--a small, but potent

storm. At 1200 on the 16th, the 980-mb center was near 43°N, 43°W. The main area of the storm was no more than 400 mi in diameter. Two ships were caught near the center. The JORDAENS had her bow into 60-kn winds and 26-ft waves in the southeast quadrant. In the southwest quadrant, the ZAWIERCIE was sailing into 50 kn with no seas reported.

On the 17th the storm turned northeastward. The buoy at 61.7°N, 29°W, reported 52 kn at 0600, and a ship off Brest reported 55 kn with 33-ft swells at 1200. At 1200 on the 18th, the storm was still small in area, but it had a strong gradient. The LEO SCHROEDER, south of the storm at 51.9°N, 23.5°W, fought 60-kn westerly winds and 33-ft seas. Other ships were finding 40- to 50-kn winds and waves around 25 ft. The storm was weakening on the 19th, but another small LOW raced in from the west and reinforced it on the 20th. The DLHO reported 50-kn winds and 26-ft waves as she headed westward. On the 21st the UUDH had 60-kn southerly winds south of Lands End. The LOW moved northward toward Iceland and dissipated by the 23d.

Monster of the Month--This storm developed off the U.S. East Coast on the morning of the 19th as a cold HIGH pushed southward over the Midwest. The instability over the Gulf Stream gave the TAMPA 55-kn winds with 20-ft waves and the TRANSPANAMA 50-kn winds with 30-ft waves off the Florida coast at 1200. At 1800 the TAMPA had 60-kn winds and 41-ft waves at 26.3°N, 74.3°W. The ARECIBO (29.9°N, 70.7°W) also suffered 60-kn winds but only 15-ft waves.

By 1200 on the 20th, the central pressure had plummeted to 956 mb near 46°N, 53°W. The strongest reported winds were well south of the center near 35°N. The DOCTOR LYKES (34.8°N, 53.9°W) had 75-kn winds, and the THORSTREAM (34.5°N, 55.2°W) suffered 64 kn. The storm was moving northward just off the east coast of Newfoundland on the 20th. Mr. Gates of the Canadian Atmospheric Environment Service reported that record low sea-level pressures were recorded at several stations of which the most notable was St. Anthony (51.5°N, 55.8°W) with 940.2 mb. He reports that this was the lowest sea-level pressure ever reported in Canada and, possibly, North America (fig. 62). Many ships reported winds in the 50- to 60-kn category. The highest was 60 kn from the south by the SKIENSFJORD at 48.5°N, 48.5°W, with 38-ft seas and a pressure of 962 mb.

The high winds and seas continued on the 21st, 22d, and 23d as the storm turned eastward. Some of the

Figure 62. --At 1700 on the 21st, the storm has moved northeastward to 51°N, 50°W, after leaving record low pressures in Newfoundland.

higher sea or swell reports were: C.P. TRADER, 62 ft; ELBE EXPRESS, 33 ft; EXPORT BUILDER, 49 ft; EXPORT DIPLOMAT, 36 ft; SKIENSFJORD, 46 ft; and DLHO, 49 ft.

On the 23d another LOW which had developed off Nova Scotia raced south of the original storm with some weakening of the winds and seas. This was followed by a second LOW on the 24th. By the 25th both of the secondary systems had been absorbed into the original circulation, and the storm was again producing high winds. The UKGS was blasted by 68-kn winds at 48°N, 41.6°W, and OWS Romeo fought 62-kn winds and 23-ft seas. A ship near 50°N, 31°W, was sailing into 41-ft swells. Winds near 50 kn were common.

Late on the 25th, the LOW began to break up into multiple centers. At 1200 on the 26th, the REVERE, south of one of the subcenters, reported 80-kn winds, and a ship to the northwest was swept by 31-ft seas. On the 27th high winds were reported in the English Channel. On the 28th the LOW rapidly weakened as it circled to the south; it disappeared on the 29th.

There is always one that is different. This storm developed off Delaware Bay and spent only a short time over the water. It circled northwestward to Hudson Bay where it turned southward.

It formed as a wave on a front early on the 25th. On the 26th it moved over the Bay of Fundy still developing. At 1200 it was 980 mb south of the Gaspe Peninsula, and its deep trough extended south to 20°N. The ANCO EMPRESS at 40.4°N, 59.8°W, was tossed by 60-kn winds and 39-ft seas and swells. At 1800 the SEA-LAND MARKET (42°N, 57.6°W) reported 45-kn winds but the swells were a monstrous 49 ft. At 0600 on the 27th, a ship appearing to be the NVYA reported 76-kn northerly winds off Cape Charles.

By the 28th the 966-mb storm was centered over

northern Quebec and the CG11 near Cape Sable was blasted by 80-kn winds. Late that day, another LOW over southern Quebec cut the circulation off from the sea.

Shipping was hampered on the bays and rivers along the northeast coast of the United States during the last half of the month. Rivers of the Midwest were frozen solid, with shipping halted or delayed north of the Mississippi-Ohio River junction.

Casualties--The 3,312-ton ANGEL sank in a storm 70 mi off Menorca. Seven of the crew of 18 were reported saved. Two separate ship collisions in heavy fog on the Sea of Marmara sank two freighters with 2 seamen dead and 28 missing. The ADMIRAL ZMAJEVIC (8,569 tons) and the TURNU SEVERIN (1,720 tons) collided and the later sank. The IVAN SECHENOV (5,626 tons) and 7,324-ton NICOLAS MARIS also collided.

The Panamanian LIZA sank in heavy weather about 350 mi east of Tampico, Mexico, on the 11th. She was in tow by the tug RUMPOINT. The UKOLA broke in two and sank on the 19th while about 200 mi west-northwest of Key West. The vessel apparently encountered heavy weather and began taking water in the holds. Of the 23 crewmen 3 were saved, 7 killed, and 13 missing. The cruise ship FANTONE, a four-masted schooner, ran aground when she lost power while 23 mi from Nassau on the 19th. Owing to heavy seas and high winds, the 110 passengers were evacuated by the U.S. Navy vessel PETROL and the U.S. Coast Guard cutter STEADFAST.

The American FORTALEZA, New Jersey to San Juan, encountered heavy weather on the 21st near the Bahama Islands. The vessel was carrying cargo in containers and 29 were lost overboard and another 20 damaged. The Coast Guard reported 60-kn winds and waves of 50 ft in the area. The Canadian AIME GAUDREAU was drifting in ice in a northwesterly direction on the 26th near St. John, Brunswick.

Rough Log, North Pacific Weather

December 1976 and January 1977

ROUGH LOG, DECEMBER 1976--The waters around Japan are spawning grounds for many of the storms that roam the North Pacific in winter. This month, this was intensified. Many of these LOWs moved east-northeastward, remaining just south of the Aleutian Islands, and recurved into the Gulf of Alaska or Bristol Bay. This activity was reflected in the nearly normal position of the Aleutian Low. The increase in activity is reflected in the negative 13-mb anomaly at the surface and the negative 136-m departure from normal at 700 mb, both located near 45°N, 180°. This position is just southeast of the normal location of the center of the Aleutian Low.

The increased activity in these waters was at the expense of the normally cyclonically active waters off the Washington-British Columbia coast. A ridge in the upper levels resulted in a positive 83-m departure centered over Vancouver Island. At the surface, this was a positive 5-mb anomaly.

Two weak tropical storms, Nora and Opal, developed in the western North Pacific. One or two tropical cyclones are not uncommon in these waters.

Extratropical Cyclones--Two weak LOWs developed on the 4th. One formed in the northern Sea of Japan and moved eastward. The other was first detected just northwest of the Mariana Islands and moved northeastward. The two merged early on the 7th near 47°N, 177°E, and the resultant system developed into an intense storm. The HONG KONG PHOENIX, some 200 mi to the southwest of the center, ran into 50-kn winds amidst 20-ft seas. A few hours later, the TAKASAKA was battered by 56-kn winds in 30-ft seas near the storm's rapidly deepening center. Central pressure plummeted to 934 mb by 1200 (fig. 63). The OJI MARU, within 100 mi of the center, reported 65-kn winds in 30-ft seas with a 946-mb pressure and continuous heavy rain. She continued to battle these same conditions as the storm moved northward to near 50°N, 177°E. The system then began to stall. It remained stationary over the Rat Islands until the 10th. On the 9th, the SAJANSKIE GORY, bobbing in 22-ft seas, reported 52-kn winds about 250 mi north of the weakening

Figure 63.--The dim appearance of the storm is from the wintertime position of the storm, not its severity. This image shows the 934-mb storm late on the 7th near 49°N, 177°E.

976-mb center. The following day the system moved eastward and continued to fill.

A LOW developed rapidly on the 10th, about 300 mi south of Atka Island in the Aleutians. Central pressure fell to 962 mb as the system headed northeastward the following day. The GUERAKL ran into 44-kn winds about 250 mi northeast of the center, while the 5LKJ encountered 45-kn winds the same distance to the east. The BREWSTER, also on the 11th, reported 40-kn winds 120 mi southwest of the center. As the storm moved northward the next day, she encountered about 6 hr of 60-kn winds. On the 12th, as the storm looped counterclockwise across southeastern Alaska and into Bristol Bay, the BREWSTER was raked by 50-kn winds, about 300 mi south of the center, as she got caught between the weakening LOW and a developing storm to the south.

This short-lived storm began on the 11th near 45°N, 175°E. It took several days to develop as it moved on a track similar to the previous system. It moved northeastward recurving over the Alaska Peninsula and then into Bristol Bay by the 14th. On the 13th, when the 960-mb center reached the Alaska Peninsula, gales extended out 700 mi to the south. The GLADIOLUS, 250 mi east-southeast of the center, and the ALISHER NAVOI, 150 mi to the south-southwest, both encountered 50-kn winds. The latter ship reported swells estimated at 47 ft. The storm began to merge with the previous one, and by the 14th just one weakening 966-mb center remained. The system hung on until the 16th.

The Yellow Sea spawned a LOW on the 15th. It moved rapidly east-northeastward as it developed. On the 17th the LIONS GATE BRIDGE encountered 60-kn winds and 25-ft swells about 180 mi southwest of the 984-mb center, which was located near 43°N, 155°E. The following day gales were reported out to 600 mi from the 972-mb center. On the 19th, the system crossed the International Dateline. Forty- to 50-kn winds were common out 450 mi in the western semicircle. This was attested to by the SOHIO INTREPID, which reported 48-kn winds in 22-ft swells northwest of the center and the UNIVERSE PORTUGAL to the southwest where winds were blowing at 45 kn and seas were running 15 ft. Even farther to the southwest, swells were running 18 to 20 ft. Conditions were also rough in the eastern semicircle. The SHIN HONSHU MARU, 250 mi to the northeast ran into 53-kn winds. Similar to other storms this month, the LOW began to recurve toward the Alaska Peninsula on the 19th. The system also began to fill. At 1200 the PRIVIV, some 300 mi to the south of the center, was hit by 50-kn winds in 25-ft seas. By the 21st the system had moved across the Alaska Peninsula to finish up in Bristol Bay.

The northern Gulf of Alaska was the scene of a strong northerly flow that produced a solid week of persistent gales. The culprit was the strong gradient between a large Siberian HIGH and a series of weak low-pressure systems that moved along the Aleutian Chain. It started on about the 19th when an environmental buoy radioed northerly winds at 38 kn with 15-ft seas near 59.5°N, 177.6°W. The buoy came back with 52 kn the following day after the UFEF encountered 42-kn northerlies. Winds in this area from 59° to 61°N just on either side of 180° ranged from 35 to 55 kn for the next week. Ships caught in these gales included the CAPE MAGDALENA, PRIOZERSK, MAIKI, NOVAYA KAKHOVKA, SAKHALINSKIE GORY, SOVIETSKAYA SIBIR, LESOGORSK, VOSKHOD, and the BIKINE. Many of these ships are part of the Soviet fishing fleet. Air temperatures were running -5°C to -15°C with the resultant wind-chill factors to near -45°C, and the potential for superstructure icing was quite high. Reports of 50 to 55 kn were common on the 22d and 23d. Then on the 24th the buoy radioed northerly winds at 62 kn, which was later substantiated by the OREL. Winds of 40 to 60 kn, creating frigid fishing conditions, continued through the day. They began to slacken somewhat on the 25th, but there were still some reports in the 40- to 50-kn range. Conditions continued to improve in these seas.

Near the International Dateline at about 47°N, a storm came to life on the 25th. Pressure fell to 974 mb the following day as conditions worsened to the south. The EATON GLORIA encountered 55-kn winds in 18-ft seas about 420 mi south of the center. Swells were running 18 to 22 ft in gales even farther to the south. The storm moved eastward, and on the 27th the 959-mb LOW was centered near 52°N, 155°W, at 0000. The PESTOVO and the UIVD encountered 50-kn northerlies some 300 to 400 mi northwest of the center, which turned northward and began to fill. However, 50-kn winds were reported throughout the day (fig. 64), and at 0000 on the 28th, the 5ZLB ran into 60-kn northwesterlies in 12-ft seas about 300 mi west of the center. The PRESIDENT JEFFERSON, the same

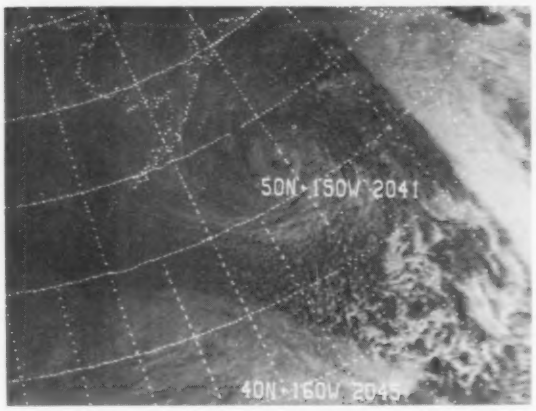

Figure 64.--Again a low sun angle makes this storm almost undiscernible. On an infrared image, it would have been a bright white.

distance to the south, was blasted by 50-kn winds in 25-ft swells. On the 29th the system deteriorated rapidly.

Tropical Cyclones--Tropical storm Nora developed in the Philippine Sea just east of Samar on the 3d. Moving westward, the tropical storm moved into the central Philippines the following day. This inhibited

further intensification as maximum winds reached 55 kn during the day. The system weakened as it recurved to the northeast. Nora dissipated as she passed south of Manila and back out into the Philippine Sea.

Tropical storm Opal popped up on the 9th about midway between Luzon and the northern Marianas. Winds near the center of this short-lived storm reached 40 kn as it moved east-northeastward. By the 10th Opal was a tropical depression and was in the process of becoming extratropical.

Casualties--In a collision in dense fog in San Francisco Bay near the Richmond-San Rafael Bridge, the 14,479-ton Swedish freighter DON CARLOS sustained damage above her waterline and had to be towed to Richmond. The CHESTER HARDING, the other vessel involved in the accident, was heavily damaged and towed to Alameda. No injuries were reported aboard either ship.

The Panamanian ship DEMEDER was lost in the seas south of Kyushu on the 26th. A distress call from the ship indicated a big crack had developed in the hull and it was sinking in rough seas. An extensive air-sea search was conducted, but the only clues to the fate of the 22 crewmen were an oil slick and two unmanned rubber boats found about 7 mi northnortheast of Yaku Island.

ROUGH LOG, JANUARY 1977--The area south of the eastern Bering Sea was congested with storm tracks. The area was bounded roughly by 35°N, 150°W, and 60°N, 180°. The storms had a more easterly component than the normal climatology until the center passed 180° where they curved sharply northward to dissipate between 55° and 60°N. There also were many storms which developed in the southern part of this congested area and traveled northward. Only three low centers penetrated the west coast of North America. Alaska was also slighted, as only one significant center moved farther north than 60°N, and that was along its west coast through the Bering Strait.

Orientation and placement of the tracks of the storm centers were reflected in the mean pressure pattern for the month. The Aleutian Low was 983 mb and centered near 48°N, 170°W, about 20° longitude east of its normal 999-mb location. The high-pressure center off the California coast was in accordance with the normal, but the center normally over the northwestern States was centered farther north and 5 mb higher than normal at 1026 mb.

The 22-mb negative anomaly associated with the Aleutian Low dominated the Pacific north of 25°N. It was centered near 48°N, 170°W. An 8-mb positive anomaly dominated the Pacific Northwest coast from Alaska to northern California.

As with the surface, the upper-air circulation center was many miles east of its climatic position. The central height at 700 mb was 86 m lower than normal, but the shift of its center from over the Sea of Okhotsk to 50°N, 180°, was probably more significant. A large negative anomaly, centered near 46°N, 172°W, covered most of the ocean north of 25°N, except for a positive area centered near the Queen Charlotte Islands. This was associated with a sharp ridge over the West Coast. This sharp ridge and the lack of storm centers off Alaska and British Columbia are closely associated.

Extratropical Cyclones--The first storm of the month had its infancy in December but matured in January. At 0000 on the first day of the year, a 986-mb center was near 39°N, 176°E. By 1200 the pressure had dropped to 966 mb, centered near 45°N, 177°W. The MONTIRON was at 43.2°N, 173°W, with 55-kn southwesterly winds. The OREL had bitter, cold 50-kn winds while fishing near 60°N. The center was on a northerly track. A ship southwest of the center had 40-kn winds and 18-ft seas on the 2d. At 0000 on the 3d, three other Soviet ships in the vicinity of 60°N, 180°, had 45- to 60-kn winds. Saint Paul Island reported roaring 80-kn winds from the south-southeast. On the 4th the LOW was integrated into the larger circulation.

This storm was part of the larger circulation. It formed in a trough on the 2d near 38°N, 167°E. Gale-force winds and 20-ft seas were already occurring. At 1200 the SEA-LAND COMMERCE had 46-kn winds and 25-ft swells near 32.5°N, 156.5°E, and the OJI MARU (33.7°N, 163.4°E) reported 57 kn and 30 ft. On the 3d there were gales in the southwest quadrant; at 1200 the PACIFIC BEAR (36°N, 173°W) had westerly 45-kn winds with 33-ft swells.

Also at 1200, this LOW disappeared. A new one that was analyzed at 0000 took over farther north. The major circulation did not change much, only the center of it. On the 4th the LOW was 958 mb, and the ASIA BEAUTY had 47-kn winds northeast of the center. At 0600 the JBDB (50°N, 142°W) fought 58-kn winds. At 1200 EB16 measured 54 kn. For that analysis this was the only closed LOW from Japan to California. Before and later, other LOWs cluttered the chart. This LOW disappeared near the Bering Strait by the 6th.

This storm began by the 0000 analysis of the 5th. It was one of the LOWs that broke up the single-LOW circulation of the 4th. At that time it was 971 mb near 41°N, 175°W. The AKADEMIK KOROLYOV, at 38°N, 180°, had 40-kn gales and 25-ft seas. The RACHEL (31°N, 178°W) was battered by 45-kn winds, 33-ft seas, and 41-ft swells. At 0600 the SHINYO MARU (34.3°N, 170.7°W) was blasted by 86-kn winds, and the KISO MARU nearby at 34.2°N, 170.5°W, suffered 64-kn winds.

The LOW raced northward. At 0000 on the 6th, it was near 50°N, 169°W, at 952 mb (fig. 65). The WZFW, at 54.2°N, 163.2°W, reported 55-kn easterly winds, 49-ft seas, and 25-ft swells. The TOYOTA MARU No. 12, near 48°N, 160°W, had 50-kn southeasterlies and 20-ft waves at 0600. The LOW crossed into the Bering Sea on a northwesterly course, which changed to westerly on the 7th, and moved over northern Kamchatka to disintegrate on the 9th.

This was another of those wandering storms that turn westward. This one also turned eastward again. At 0000 on the 6th, it was at 38°N, 158°E. Minimum gale-force winds were blowing in the southern half of the circulation. At 0000 on the 8th, the INDIAN MAIL

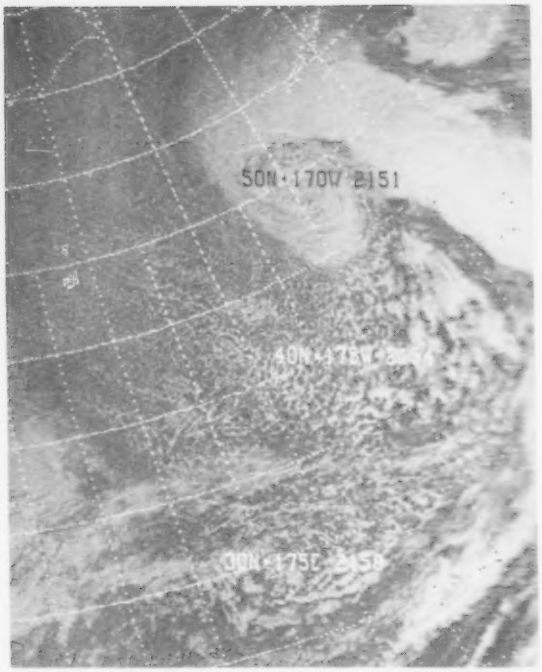

Figure 65.--At 2151 on the 5th, the LOW is near 50°N, 170°W.

Figure 66.--Almost twin storms as far as appearances except the cloud pattern immediately south of the center.

(36°N, 178°E) was sailing with 26-ft swells on her stern. At 0600 the KINYO MARU, at 40.7°N, 177.2°W, had 55-kn winds and 33-ft waves. The PLUTOS had 30-ft seas and the INDIAN MAIL 26-ft swells.

At 0000 on the 9th, the 962-mb LOW was at 48°N, 171°W--its most easterly position. The PRESIDENT MADISON was taking 50-kn winds and waves to 30 ft. At 0600 the winds increased to 55 kn near 43.5°N, 151.4°E. There was an area south of the center between 30° and 37°N and 165° and 175°W where four ships all reported over 25-ft waves. There were winds of 50 kn both north and south of the storm's center on the 10th. At 1200 the UIGW fought 50-kn winds and 33-ft swells near 35°N, 178°E. On the 11th the UNION PROGRESS (32.5°N, 157.7°E) had 60-kn westerly winds. Late in the day the storm turned northward, then eastward again on the 12th. There was a large expanse of weak low pressure between three centers, and on the 13th the southeastern one took over the circulation.

A minor trough left over from a previous secondary low-pressure center was the impetus for this storm center. It was one of many that rotated around the primary LOW associated with the long wave circulation. At 1200 on the 15th, it was 966 mb near 43°N, 160°W. By 0000 on the 16th, the LOW was 946 mb near 47°N, 156°W (fig. 66). Except for the latitude and dynamics involved, it had the appearance of a tropical cyclone. Along the cold front a ship at 29°N, 168°W, was hit by 75-kn winds and 30-ft swells. Farther to the northeast, also along the front, the STREAM HAWSER found 33-ft swells at 33°N, 161°W.

The CROWN PEARL, a 5,450-ton freighter, with a cargo of logs sustained a cracked hatch about 300 mi northwest of Midway Island. The vessel was taking on water and listing heavily. The crew abandoned ship and were rescued by the ROMANDIA (20,797 tons) which proceeded to Kobe. The ASIA LOYALTY put a line on the drifting CROWN PEARL on the 21st and commenced towing the abandoned vessel to Honolulu. About 500 mi from Honolulu on the 23d, the CROWN PEARL sank.

The AKADEMIK SHIRSHOV was near the British Columbia coast with 82-kn winds from the south and 23-ft waves.

The storm was centered near 56°N, 157°W, at 0000 on the 17th. The CHEVRON MISSISSIPPI (55.5°N, 146.3°W) had 50-kn easterly winds. At 0600 the ALASKA STANDARD had 55 kn near 58°N, 152°W. By 1200 this LOW absorbed the major circulation center, which had been weakening, and became the major center. The whole system was filling, and the gradient was relaxing with mostly minimum gales. On the 18th the center was on a westerly track, which meant the end was near for this center.

The major circulation still existed, and it was the only cyclonic center from Asia to North America (fig. 67). There was an anticyclonic circulation associated with a high-pressure center over the western United States. There were three trough lines in the cyclonic circulation spaced between Necker Island and Marcus Island. At 0038 on the 18th, the 21,090-ton Liberian

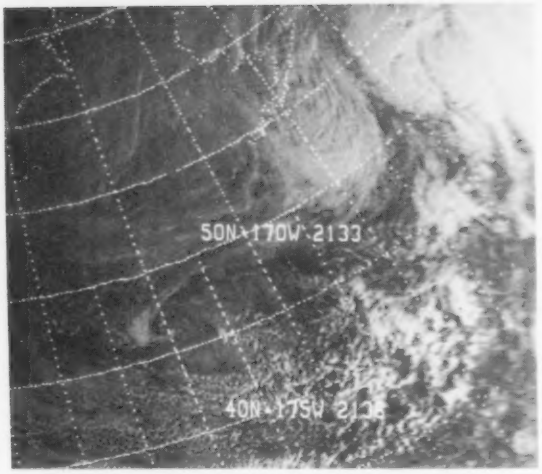

Figure 67.--A close examination reveals the circulation center near 47°N, 180°. The front extended from the clouds in the upper right-hand corner.

tanker IRENES CHALLENGER sent an SOS and was sinking about 200 mi southeast of Midway Island. She had broke in two (fig. 68). The PACIFIC ARROW rescued 28 of the 31 crewmen. Three who remained on board were missing. Weather conditions in the area were reported as extremely bad, but winds of around 40 kn and waves up to 20 ft were the highest indicated on the charts.

This was another short-wave LOW. It began on the 18th and traveled around the periphery of the major circulation described above. It moved basically eastward, bringing only wind shifts to ships in its path until the 20th when it was 974 mb near 44°N, 164°W. At 0000 the 7JBL found 70-kn winds near 45°N, 170°E. At 1200 the HAKUSAN MARU (42.5°N, 164.8°W), about 100 mi southwest of the center, fought continuous heavy rain with 60-kn winds and 21-ft waves. At 1800 the winds were still 60 kn but shifted to the west. By the 21st the LOW had combined with another.

This minor LOW, which started at 1012 mb south of Shikoku on the 23d, became the major long-wave LOW. For the first few days it raced eastward under the influence of the zonal winds. On the 24th at 0000, it

Figure 68.--The 600-ft oil tanker IRENES CHALLENGER lies broken in two. A day later, both halves were still afloat but a mile apart. Wide World Photo.

Figure 69.--The bow of the squid boat DAIMARU No. 2 is held by the jagged rocks. Note the line off the bow. Wide World Photo.

was already 988 mb near 35°N, 153°E. The HONG KONG MAIL found 45-kn gales and 25-ft seas and swells at 34.3°N, 150°E. The ASIA BOTAN was swept by 60-kn winds near 34°N, 159°E. At 0600 they increased to 72 kn, and the EATON GLORIA at 32°N, 152°E, fought 63-kn winds and 33-ft seas and swells.

At 0000 on the 25th, the LOW was expanding and deepening rapidly to 962 mb near 38°N, 172°E. The ASIA BOTAN was gingerly continuing on her easterly track with 100-kn northwesterly "winds." The swell was 33 ft. Several other ships in the vicinity radioed 60-kn winds. The 50- to 60-kn winds continued with 30 ft the highest wave reported. South of the low center was a bad place to be caught. At 0000 on the 26th, the ASIA BOTAN was still experiencing 80-kn winds. The ERIKA BOLTEN, at 36°N, 171.5°W, was headed into 64-kn west-southwesterly winds with 39-ft seas. At 37.3°N, 175°W, the ARNOLD MAERSK was headed into 56-kn westerly winds and what was coded as 62-ft seas. Six hours later, the BOLTEN had only 33-ft seas, and the swells pounding the MAERSK were 54 ft.

The LOW, now tracking northeastward, was the major cyclonic circulation over this ocean. On the 27th, its influence stretched from Alaska to 20°N. Maximum reported winds were in the 50-kn category. and the highest waves were 36 ft. The lowest pressure was 952 mb. By the 28th the storm was weakening, and another was on its heels trying to catch up. A Japanese-registered ship reported 36-ft swells near 45°N, 175°W. The ARNOLD MAERSK was following the LOW eastward with 30-ft seas 700 mi south of the center. Early on the 29th the new two-center storm to the west took the lead.

Casualties--The fishing vessel SALU sank off Kodiak Island in heavy weather on the 3d. The crew was rescued. The jack-up rig SCAN SEA encountered heavy weather during a relocation in the South China Sea and capsized. All crewmembers were disembarked or picked up and taken to Singapore. The Japanese squid boat DAIMARU No. 2 (fig. 69) went aground on the west coast of South Island, New Zealand, on the 4th. All 13 crewmen were rescued by helicopter in gale-force winds.

Marine Weather Diary

NORTH ATLANTIC, APRIL

WEATHER. During April, weather conditions over the middle and northern latitudes are generally much more settled compared to the preceding month. Thus, intervals of favorable weather are more frequent and usually of longer duration. There is a notable reduction in the frequency and intensity of winter-type LOWs. The 1007-mb Icelandic Low lies off Kap Farvel near 59°N, 41°W. The Azores High (1021 mb) is centered more than 1,700 mi farther south near 30°N.

WINDS. The prevailing wind north of 40°N is generally from the westerly quarter of the compass except over the Norwegian Sea, where winds are quite variable. Within this large belt, about 55 percent of the observations report winds of force 4 to 6. From about 40°N southward to the northern boundary of the trades, the prevailing wind is mostly southwesterly, although winds with an easterly component are prevalent off the east coast of Florida out to 70°W, and over the Gulf of Mexico. Near the coasts of Morocco and Portugal, northerly winds dominate, and westerly and northwesterly winds hold sway over the Mediterranean Sea. The winds north of the trades and south of the westerlies are weaker than their counterparts north of 40°N--only about 45 percent of all observations yield winds of force 4 to 6. The trades are more firmly entrenched in April, as compared to March. They usually prevail south of 25°N and, in the eastern North Atlantic, extend to about 30°N. Fifty to 75 percent of the time, they are force 3 to 4.

GALES. The area subject to gales decreases greatly in the middle and northern latitudes, compared to March. The most southern point of the 10-percent frequency boundary has moved northward to 53°N, 45°W. The area affected is enclosed by that point to 60°N, 15°W, to 62°N, 25°W, to 65°N, 28°W, to 63°N, 55°W, to 53°N, 45°W. A small area (about 6° square) of 10-percent frequency is centered east of the Grand Banks near 47°N, 38°W. Gales also spread over the Gulf of Lions about 10 percent of the time.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during the spring months (March, April, and May) are found in a broad area from Cape May down to Georgia on the United States east coast, eastnortheastward out to the central ocean, including the waters around Newfoundland. Within this region, cyclogenesis is concentrated from the coasts of Virginia and North Carolina northeastward to a point near 39°N, 66°W. Other principal areas of cyclogenesis lie around the south coast of Iceland; over most of the Baltic Sea, including Danish waters, but not including the Gulf of Bothnia; off Norway's arctic coast; over the Bay of Biscay; and over the Gulf of Genoa, the northern and central Adriatic Sea, and the southwestern Black Sea. Primary storm tracks in April are much the same as in March. One track begins about 250 mi east of Cape May and travels northeastward over the Grand Banks. The storms heading northeastward across the North Atlantic tend to pass a little farther south of Iceland than in March. Over the Mediterranean, the primary storm track reaches northern Italy, but does not extend to southern Turkey as it did in March.

TROPICAL CYCLONES have not been reported during April in the North Atlantic in the past 104 yr. This is the only month of the year in which no tropical storm activity has occurred.

SEA HEIGHTS of at least 12 ft are found more than 10 percent of the time north of a line extending from Labrador around the eastern margin of the Grand Banks to 41°N, 50°W, westward to 70°W. The same line curves eastward along the 36th parallel to 60°W, and then across the North Atlantic to Ireland and central Norway. Another small area of 10-percent frequency extends from the Gulf of Lions southeastward to a distance of 150 mi out over the Mediterranean. An elliptically shaped area of 20-percent frequency extends from latitude 55° to 60°N, and across longitudes 15° to 55°W.

VISIBILITY. Occurrences of low visibility increase over the western part of the North Atlantic, especially west of 40°W. The greatest change from March takes place over the Grand Banks and the waters south and east of Newfoundland, where over 20 percent of the observations show visibilities of less than 2 mi. Visibility over the Norwegian Sea has decreased in the west and increased in the east. The area of 10-percent frequency of low visibility over the North Sea has moved southwestward and extends from the tip of southern Norway to the coast of Great Britain.

NORTH PACIFIC, APRIL

WEATHER. The weather over the North Pacific generally shows marked improvement over that of any month since October. Compared to the winter months, periods of storminess are fewer, but severe extratropical LOWs are still encountered occasionally. The Aleutian Low has filled to three 1009-mb centers along 55°N. Its configuration is that of a banana, bridging from the Gulf of Alaska to the Sea of Okhotsk. The 1012-mb isobar orientation has changed very little over the past months, except the southern boundary has moved steadily northward with spring, now approximating 50°N. The three LOWs are located just east of Kamchatka, in the middle of the Bering Sea, and in Bristol Bay. The Pacific High is expanding with two major centers near 32°N, 159°W, and 32°N, 178°W.

WINDS. Over about half of the North Pacific between 40° and 55°N, the windspeeds are of force 4 to 6 in 50 to 65 percent of the observations. The remainder of this latitudinal belt, especially near the coast of North America, experiences winds of force 3 to 5. The prevailing winds are from the westerly quarter. Between 30° and 40°N, winds are variable west of 170°E, mainly southwesterly between 170°E and 150°W, and westerly to northerly east of 150°W. Forces 3 to 5 are recorded in 45 to 70 percent of the observations. Variable force 5 winds often blow over the western half of the Bering Sea, and northerly force 5 winds are quite common over the eastern half. Easterly winds of about force 4 sweep over the northern Gulf of Alaska. South of Japan, easterly force 4 winds prevail, and winds from any direction except west and southwest are common over the East China Sea, where force 3 to 4 is the rule. The "northeast trades" prevail south of 25°N, over the western ocean between the dateline and the Philippines, and south to 30°N over eastern waters. The trades blow at about force 4, except near the Equator and over the Philippine Sea, where force 3 winds prevail. The northeast monsoon continues to dominate the South China Sea, but with less strength and steadiness than in the colder months. Winds of force 2 to 3 account for between 46 and 63 percent of all observations. Northerly winds continue to prevail south of the Gulf of Tehuantepec, but gales over the Gulf now occur less than 5 percent of the time. Force 2 to 3 winds are experienced 50 percent of the time, compared to 40 percent in March.

GALES. Two areas of high gale frequencies, 10 to almost 20 percent, persist as a residual of the winter month in the middle and northern latitudes. One holds sway over the Gulf of Alaska south of Kodiak Island to about 52°N, and eastward to near 140°W. The other is a belt 250 to 370 mi wide that lies east of Honshu from about 36°N, 147°E, northeastward to about 45° to 48°N, and 178°E.

EXTRATROPICAL CYCLONES. The principal area of cyclogenesis stretches from south of Kyushu northeastward to about 700 mi south of Beringa Island. A primary track from across Sakhalin Island combines with the one above and follows the Aleutian Islands into the Gulf of Alaska. About 180°, a branch shoots off to the northeast toward, and over, the Pribilof Islands. About midway between Hawaii and Adak, a track points northeastward toward Yakutat. A secondary cyclone path enters British Columbia near the southern tip of the Queen Charlotte Islands. The storm tracks have moved slightly northward over the western waters. The intensity of the storms has started to decrease, resulting in fewer gales.

TROPICAL CYCLONES. In an average 10-yr period, about seven tropical storms can be expected over Far Eastern waters. About 80 percent of these, or 4 out of 5, have developed to typhoon strength. Tropical cyclones develop in the same region as they did in March, east of the central and southern Philippines and west of 170°W, but the area affected by these warm-core storms has expanded northwestward to include the waters east of Luzon and around Taiwan. A tropical cyclone in the eastern North Pacific in April would be a rarity.

SEA HEIGHTS. The area where there is at least a 10-percent frequency of 12-ft, or higher, seas is roughly bounded by 155°E and 150°W on the west and east, 52°N on the north, 32°N on the southwest corner, and 45°N on the southeast. An area of 10-percent frequency of swells equal to, or greater than, 12 ft parallels the coastline of North America, including the Aleutian Islands, and joins the western half of the above area.

VISIBILITY. Reduced visibility (less than 2 mi) of 10-percent, or greater, frequency extends to the north of a line drawn from Sakhalin southeastward to about 40°N, 160°E, and then east-northeastward to about 45°N, 175°W. From there the line swings northward to Amlia Island in the eastern Aleutians, and then eastward to about 50°N, 150°W, before cutting back across the Alaska Peninsula to the Bering Sea, east of St. Lawrence Island. The area of 20-percent frequency has decreased in size since March and is now centered over the northern Kurils.

NORTH ATLANTIC, MAY

WEATHER over the North Atlantic continues to moderate during May. The Azores High builds slightly to a central pressure of 1022 mb near 31°N, 40°W, while the Icelandic Low centered several hundred miles southeast of Greenland's southern tip fills to about 1012 mb.

WINDS over the greater part of the ocean between 40° and 55°N are generally westerly, except northeasterly over the Baltic Sea, but with less persistence than earlier in the spring. The average windspeed north of 40°N is force 4. Winds are quite variable between 55° and 60°N and are generally northerly north of 60°N. Between 25° and 40°N, winds are somewhat lighter, generally of force 3. West of 40°W, within the above latitudinal belt, south and southwest winds tend to prevail; while east of this longitude, winds from the northerly quarter of the compass are by far the most frequent of all. Over Mediterranean waters, westnorthwesterly winds of force 2 to 3 are the most common. The Gulf of Mexico plays host to easterly force 3 winds. The "northeast trades," force 3 to 4, dominate the wind regime between 5° and 25°N, except along the African coast, where they extend northward to about 30°N. South of 5°N to the Equator, the force 2 to 3 winds almost always have an easterly component.

EXTRATROPICAL CYCLONES continue to develop frequently from off the Carolina coast northeastward to Newfoundland, but are becoming less severe. The direction of movement from Newfoundland is generally either north toward the Davis Strait, or northeast toward the Norwegian Sea. Two primary tracks affect the Great Lakes. One runs east-southeastward from Lake Winnipeg to south of James Bay. Another follows a line from eastern Iowa across southern Lake Michigan and southern Lake Huron to lower Quebec. After meeting, the two tracks proceed as one to the Gulf of St. Lawrence.

GALES are rare below 40°N, and their frequency and duration in higher latitudes are less than in the preceding months. The area of maximum likelihood of gales, 10 to 20 percent, generally is located from the southern tip of Greenland southward to about 52°N, between 40° and 56°W.

TROPICAL CYCLONES are infrequent during May. During the 44-yr period 1931-74, nine tropical storms have occurred, and two of them attained hurricane force.

SEA HEIGHTS of 12 ft or more are encountered from 5 to 10 percent of the time along the northern shipping lanes, from several hundred miles east of the Chesapeake Bay to the northern Norwegian coast, excluding the North Sea and the Bay of Biscay, but including the Gulf of Lions southeastward to Sardinia. The frequency increased to more than 10 percent in the midocean area and to more than 20 percent south of Kap Farvel.

VISIBILITY limited to less than 2 mi is encountered 10 to 20 percent of the time over the western North Atlantic, from about 40°N, 65°W, northeastward to a point near 55°N, 30°W, and then westward to the Labrador Sea. The line, north of which frequencies are greater than 10 percent, but less than 20 percent, then extends northeastward over Kap Farvel to north of Iceland, and through the Norwegian Sea to the Barents Sea. Visibility less than 2 mi also occurs between 10 and 20 percent of the time over a great part of the northeastern North Sea. Frequencies increase to over 20 percent of the time over the Grand Banks and off the southwest coast of Greenland.

NORTH PACIFIC, MAY

WEATHER continues to improve slowly over the North Pacific in May. The subtropical High has an average central pressure of about 1022 mb and is located near 34°N, 152°W. The Aleutian Low becomes a broad weakening trough extending from the Asian mainland eastward to the western Gulf of Alaska. The lowest

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pressure, about 1008 mb, is centered over the west-central Bering Sea.

WINDS north of the 25th parallel tend to come from the westerly quarter of the compass, but variable winds are present over a number of locations on either side of the dateline. Winds over the Gulf of Alaska are easterly at force 3 to 4. Along the coast of the United States, northwesterly components are pronounced. Between the Equator and 25°N, (30°N, east of 180°), the "northeast trades" are very steady, except over the southern half of the South China Sea, where southerly winds of the southwest monsoon have established themselves. These monsoon winds are usually force 2 to 3, though lighter winds are not unusual. Over most of the rest of the North Pacific, windspeeds average force 3 or 4. Northerly and westerly winds prevail out from the Gulf of Tehuantepec, with easterly and northwesterly winds close behind. Speeds are force 2 or 3, 48 percent of the time.

EXTRATROPICAL CYCLONES continue to develop over the Ryukyus and then move east-northeastward toward the Gulf of Alaska. A second primary storm track crosses the Siberian coast and Sakhalin, continues eastward across the northern Kuril Islands, and then curves toward the southern Bering Sea.

GALES decrease in frequency. In midocean between 40°N and the Aleutians, the chance of encountering gale-force winds remains slightly above 5 percent. Two smaller areas of similar frequency are found near the Alaska Peninsula and over the southern part of the Gulf of Alaska.

TROPICAL CYCLONES. Tropical storms occur, on the average, slightly more than once each year over the western ocean. There have been some years with none, but some with as many as four. Roughly 75 percent of these tropical storms become typhoons. The areas of most frequent development are south of 20°N, from the Carolines westward across the Philippines and the South China Sea. About once every 2 yr, a tropical storm or hurricane develops over the ocean area off Mexico during May.

SEA HEIGHTS. Seas of 12 ft or more continue to decrease in frequency as the winds decrease. The area of 10 percent or greater has the shape of a long balloon squeezed in the middle. The northern boundary parallels the Aleutian Islands about 400 mi to the south, between 160°E and 148°W. The southern boundary is 40°N over the western, and 45°N over the eastern ocean. High swells continue to be observed off the Asian and northern coasts, with a larger area in midocean very roughly bounded by 30° and 50°N, 155°E and 170°W.

VISIBILITY less than 2 mi occurs more than 10 percent of the time over the western North Pacific Ocean north of 35°N, and over the eastern North Pacific Ocean north of 42°N and west of 140°W, excluding the Gulf of Alaska and the waters southeast of the central Aleutians. Over the northern Kurils, this low visibility occurs more than 30 percent of the time.

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